WAYS OF THINKING ABOUT THE APPARENT CONTRADICTIONS BETWEEN SCIENCE AND RELIGION

by

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Abstract

This study looked at how people respond to the apparent contradictions between modern science and Biblically based religion. The research presents a typology of approaches to science-religion dilemmas and describes the wide range of approaches taken by experts in the area and laypeople.

The primary instrument for data collection was a semi-structured interview which used direct personal questions and questions about science-religion dilemmas. Interviews with a sample of 20 undergraduate students revealed several strategies that are not described in the formal academic literature. A five-fold typology was devised which included these strategies.

A dimension of developmental levels was identified in the transcripts, based on each individual's ability to identify and reflect on the apparent contradictions and on students' self-descriptions of their past approaches. The findings were used to devise a conceptual sequence to describe the cognitive development that takes place in this kind of thinking.

A method of analysis was devised which inferred information about students' views of science and religion from the apparent contradictions that they identified. It was found that many students held views of science and religion that were in conflict and that they had not examined these views.

The scheme was original in that it was based on semi-structured interviews about dilemma situations in the area, and it was accompanied by a relatively precise scheme of analysis.

The conceptual sequences presented here could become the foundation of a developmental sequence, showing how students might advance in their thinking about science-religion dilemmas from novice to expert. In the field of cognitive development, many researchers including Piaget and Kohlberg have used cross-sectional designs when formulating developmental sequences. Once the initial concepts have been established, studies with a longitudinal design have been used to test and confirm the sequences.

In the study here, a single age group was used and the descriptions of students' thinking cannot be presented as developmental sequences. The stages do, however, follow from one another conceptually. Further studies could look for evidence that they follow one another in time.

When devising the conceptual links between the steps in the sequence, attention was paid to the published responses of philosophers, theologians and scientists to these kinds of science-religion dilemmas. These responses made by experts in their fields were studied with a view to discovering the characteristics of the thinking of individuals at the most advanced stage within the conceptual sequence.

The analysis method developed in the project was applied to a second sample of 20 interviews.

The findings of this research have implications for the teaching of science and religion at school and university. It has been suggested that when students with a Christian background reach adolescence, some students discard their religious beliefs on the basis that they seem like fairy tales, while other students reject science because it is perceived

to oppose their religious beliefs and a third group find the simultaneous contemplation of science and religion too challenging to bear. To prevent these outcomes, it has been suggested that students should be exposed to more sophisticated ways of thinking about science-religion dilemmas. This research indicates that if students are to consider these alternative ideas, they will need to simultaneously explore other views of science and religion. It is also argued that one way to raise students' interest in learning more about the natures of science and religion would be to hold classroom discussions about science-religion dilemmas.

PART 1: INTRODUCTION

CHAPTER 1
INTRODUCTION

1.1 The Aim of the Research

Does the universe have a purpose? Is life here by anything other than an accident? These are the so-called Big Questions (Haught, 1984) that occupy the minds of most people at some time during their lives. A survey carried out in the early 1980s found that more than seventy-six per cent of adults in a sample of over a thousand Australians think about the purpose of life sometimes or often (Campbell & Curtis, 1996).

In their quest for ideas, individuals may turn to the accounts provided by science and/or religion. Both offer answers. These answers, however, are not the same and for many people, appear to be incompatible. At school, a typical science course for senior students includes references to the origins of the universe and the origins of life. On these issues, the inconsistencies between the scientific and the Judeo-Christian accounts are striking. Students observe that God, who is at the focus of the Biblical accounts of Creation, is not mentioned in the scientific accounts. One response to these two contrasting viewpoints is to say that science has replaced religion, and that the Biblical descriptions of acts of God are no more than myths. This is the Scientific Materialist's viewpoint, which has been notably advocated by the philosophers Hume, Huxley, Mackie and Russell, (Desmond, 1998; Hume, 1993; Mackie, 1982; Russell, 1927).

Many students find the implications of the science perspective disturbing. In the passage below a student writes on the Internet about the tension he feels when he reflects on the discord between science and his religious beliefs:

> Given our universe filled with over a billion galaxies ... What meaning of any "cosmic" significance is there then to homo sapiens? ...What hope do we have in times of grief, illness and terror, if death is no longer a step to a better world but a recycling of our atoms and molecules into the ecosystem of a planet which is itself merely a dust mote in endless intergalactic space?
>
> (Russell, 1990)

Despite the apparent challenges presented by science, a large percentage of the population maintain a religious faith. More than eighty per cent of Australians said in a survey that they believe in God and two thirds said they pray (Bouma, 1986, p. 167). It seems pertinent to ask whether these individuals have reconciled their religious beliefs with the description of the universe that modern science presents. The study described in this thesis emerged from a desire to answer this and related questions.

This research aimed to advance current understanding of how laypeople and experts think about the apparent contradictions modern science and Biblically based religion by discovering the psychological mechanisms, strategies and cognitive limitations that underlie their responses to science-religion dilemmas.

The research questions were:

- What psychological mechanisms and strategies do individuals employ when they encounter a science-religion dilemma?
- How do the approaches taken by laypeople compare with the approaches taken by academics?
- What skills and understandings do individuals acquire as they advance from novice to expert in this area of thinking?
- How does the range of approaches available to an individual depend on his or her stage of cognitive development in this area of thinking?

To address these questions, a semi-structured interview schedule was constructed which included direct personal questions and questions about science-religion dilemmas. A total of 40 undergraduate students were interviewed. Comparisons were made with the ways in which academic experts think about these kinds of dilemmas. Their approaches were discovered by studying the formal academic literature.

The outcomes of the research are a greater understanding of the wide range of strategies that students employ when they encounter a science-religion dilemma; and an understanding of how and why laypeople's approaches to dilemmas may be different to those described in the academic literature.

1.2 Methodology

1.2.1 Production of a Five-Fold Typology

In the first part of this project, 20 undergraduate students took part in semi-structured interviews in which they were asked to discuss three written science-religion dilemmas. Students also gave self-descriptions of how they usually responded to science-religion dilemmas when they encountered them outside the interview. Drawing on these self-descriptions of students' approaches and on the strategies that students were observed to take during the interview, qualitative descriptions were produced of the approaches that students take when they encounter a dilemma. The strategies included some that are not described in existing typologies of expert approaches, such as choosing not to reflect on the dilemma. Students' reluctance to confront the apparent contradictions has been noted before, for example by Scharmann (1993), Schneller (1982) and Smith (1994), but prior to this research these mechanisms have not been presented systematically. Here, an original five-fold typology was devised which included avoidance strategies as well as the strategies in which individuals engage in thinking about the apparent contradictions.

1.2.2 Students' Approaches to Written Dilemmas

The next part of the project focussed on the students' responses to the written dilemmas and in particular the so-called engaged approaches, in which students identified apparent contradictions, rather than approaches that involved avoiding confronting the issues. The contradictions that students identified were found in many cases to relate to a determinable and repeated set of themes. The same themes were found in the formal academic literature that describes the views of science and religion that have been held at different times in history. In the literature that describes this history, particular types of perceived contradictions are attributed to the holding of particular views of science and religion. It was hypothesised that students' perceptions of contradictions were influenced by their views of science and religion. An analysis system was developed that inferred a view of science and a view of religion from the contradictions that each student identified. When this system was used to analyse the interview transcripts, it was noted that for most students, the views of science and of religion that were inferred from the perceived contradictions were self-consistent.

Further indications of content validity were produced when the transcripts were coded to identify and label the occasions on which students directly described the natures of science or religion. The findings obtained by this method were in agreement with the findings via the contradiction-type analysis method. Overall the research found a high degree of consistency and logical thinking in students' responses. This is perhaps surprising in the light of previous studies which indicated that secondary school students showed "unexpected complexity and apparent internal inconsistency" within their individual personal views (Fysh & Lucas, 1998a, p. 63).

The views of science that the students in the sample were inferred to hold resembled Scientific Materialism and Scientific Determinism. Both of these views lead to a perception of contradictions between science and assertions of theistic action. In this thesis, the term "theistic action" refers to acts of God that are said to have happened since the Creation. The finding that students saw science and theistic action as incompatible seemed to explain the finding of this research and previous studies that many students who seek a view of the universe that combines religious and scientific beliefs, say they

are unable to resolve the apparent contradictions between them (Dagher & BouJaoude, 1997; Scharmann, 1993; Schneller, 1982; Smith, 1994). This finding is of particular interest given that in recent times, many religious scientists have published their views that the real relationship is harmonious. This raised the questions, had students considered the approaches advocated by the religious scientists and if so, why had they rejected them? An examination of the transcripts showed that students were not aware of alternative views of the nature of science, and had not considered the alternatives that are described by the religious scientists.

The third part of the research presented conceptual sequences that could provide the basis for developmental sequences, showing how students advance in their thinking about science-religion dilemmas. Were the sequence to be verified, it would show that students broaden the scope of their examination of the natures of science and religion each time they advance through the four steps that are described in the sequence.

In the field of cognitive development, many researchers including Piaget (1930) and Kohlberg (1964) have used cross-sectional designs when formulating developmental sequences. Once the initial concepts have been established, studies with a longitudinal design have been used to test the validity of the sequences.

In the study here, a single age group was used and the descriptions of students' thinking cannot be presented as developmental sequences. They do, however, follow from one another conceptually. Further studies could look for evidence that they follow one another in time.

When devising the conceptual links between the steps in the sequence, attention was paid to the published responses of philosophers and scientists to these kinds of science-religion dilemmas. This sample of views, from what was presumed to be the most developed part of the population, was formed for two purposes. Firstly these views provided an ideal model of what a rational and consistent observer would say about the interaction between science and religion, which could be compared with the responses made by the undergraduate students in the study. Secondly the views of these experts were studied to form an understanding of the characteristics of the most advanced category within a conceptual sequence of cognitive development for this kind of thinking.

Thus this research presents for arguably the first time, a typology of approaches to science-religion dilemmas in which the categories are organised to reflect conceptual sequences that with further research could be the basis of a developmental sequence for this kind of thinking.

1.3 Overview of the Literature Review

Three areas of research are relevant to this study. These are research into cognitive development, studies of the students' attitudes towards science and religion, and the academic literature on the relationship between science and religion.

1.3.1 How the Existing Literature Addresses the Research Question

The project aimed to describe how laypeople and experts respond to the issue of the apparent contradictions between science and religion and to present the approaches in a logical typology. Were the sequence to be verified, it would show the approaches that are available to individuals at each stage of cognitive development in this kind of thinking.

There are today several typologies that describe how experts think about the relationship between science and religion and these are described in Chapter 2. As will be shown, however, these are not ideally suited to the task of describing the approaches taken by laypeople.

When addressing the research question, it was found that many pieces of the jigsaw were missing when this study began. In section 1.3.2 and section 1.3.3 there are descriptions of two gaps in current knowledge that were significant for this project.

1.3.2 Students' Approaches to Science-Religion Dilemmas

At the time when this project began, descriptions of how students approach science-religion dilemmas mostly consisted of qualitative descriptions based on interviews with a small number of school students or tertiary students. These variously indicated that

students are deeply concerned (Esbenshade, 1993) or largely ambivalent (Fysh & Lucas, 1998a) about these issues.

The methodology used by Schneller (1982) has some similarities with the approach taken in my study although the two studies were conceived separately. Schneller presented brief paragraphs of text to students that described science-religion dilemmas. Students were then asked to select between a limited set of written responses, based on selected viewpoints that are presented in the formal academic literature. The methodology used in my study was different in this regard in that students were asked to generate their own responses.

Schneller reports that most students chose a so-called "Affective response" (1982, p. 258). This response stated that science and religion cannot contradict each other since both reflect God's word, but did not explain how the apparent contradictions can be removed. Schneller adds that in this way, most students avoided thinking about the details of the dilemma. Schneller is not satisfied with this result, on the basis that his aim was to discover how students think about the apparent contradictions. Indeed, in general, in previous studies, the tendency by some students to take this approach has been described as an inconvenience rather than a topic of study (Scharmann, 1993; Schneller, 1982; Smith, 1994). In a subsequent study, Schneller removed this option from the list that he offered to students. This left four responses for students to choose between which were again based on the approaches described in the literature.

It can be argued that the responses prepared by Schneller (1982) which he explains were drawn from the academic literature, included ideas that some students could not have produced without assistance and did not include all the responses that students would have generated if they had been asked to respond freely. The methodology used by Schneller leaves the way open for a project like this one, that asks students to generate their own responses and which consequently obtains their responses on these issues more directly and more authentically.

The typology produced in this research includes the strategy of avoiding the apparent contradictions. It also includes the "dualistic" approach in which science and religion are mentally compartmentalized, an approach that was first proposed by Goldman (1965).

The mechanisms underlying these approaches are of interest because they appear to explain how some individuals maintain a religious outlook while aware of unresolved contradictions.

1.3.3 Stages of Cognitive Development in this Area of Thinking

A second gap in the literature at the time of embarking on this research was that there was not an accepted model to describe the stages of cognitive development that take place in regard to how people think about these dilemmas. A conceptual sequence that could be used as the basis of a developmental sequence was constructed for this research drawing on the characteristics that emerged when studying the approaches taken by the students and those described in the academic literature.

1.4 Applications of the Research

This research produced several important findings for teachers of science and religion. The research provides an in-depth understanding of how students approach science-religion dilemmas and why from the students' perspectives, there are relatively few ways to resolve the dilemmas. The range of approaches available to students is limited not least because they assume that science is deterministic or in some cases, materialistic. Previous studies have shown that many science teachers are reluctant to teach topics that they see as controversial (Ebenezer, 1996; Scharmann, 1993). Endowed with a greater understanding of the ways in which students are likely to interpret the language of science, science teachers may be able to convey the ideas of science using terms that do not alienate students who have religious backgrounds by reinforcing a narrow and negative perspective about the relationship between science and religion.

1.5 Terms and Scope of the Research

1.5.1 Science and Religion

This research discusses the apparent contradictions that arise between Western science (which is frequently referred to in this thesis as "science") and Judaeo-Christian-Islamic religion (which is frequently referred to in this thesis as "religion").

1.5.2 Conflict, Contradictions and Tension

Early in this study, it emerged that the term "conflict" can be used to mean different things. In pilot interviews, some students used the term "conflict" to mean "contradict", while other students only used the term "conflict" if they experienced emotional tension regarding the perceived contradictions.

These two meanings also appear in the literature. In his 1982 paper, Schneller presents a definition of conflict that highlights the emotional aspect of the term. Schneller begins by explaining that if two statements are contradictory, it means that accepting one precludes the logical possibility of accepting the other. Conflict occurs when "one wants to retain and accept both of them" (Schneller, 1982, p. 256).

An alternative definition of the term of "conflict" focussing on the idea of incompatibility alone is given by Duce (1998):

> An instance of conflict would be any situation where scientific explanations (via reason and the senses) teach X while theological explanations (via scripture) teach Y, but it is impossible that both X and Y can simultaneously be true. (p. 85)

In this research, the term conflict is avoided. Instead the term apparent contradiction is used to refer to apparently incompatible assertions. The term "tension" is used to refer to the angst that some individuals experience regarding science-religion dilemmas.

1.5.3 Apparent and Real Contradictions

In discussions about the relationship between science and religion, a frequent focus of debate is whether science and religion "really" contradict.

For example, the statements "God created humans" and "evolution produced humans" clearly don't mean the same thing, but it is a matter of opinion as to whether they are mutually exclusive. If two statements contradict, it follows that the acceptance that one is right means that logically, the other must be wrong. An individual who takes the view that human life began with Adam and Eve would surely say that the statements are exclusive. Meanwhile another individual who took the view that God created evolution would say that there is no contradiction. For this reason, in this study contradictions are called "apparent", since it is not agreed that they are "real".

1.5.4 The Terms "Approach" and "Dilemma"

The term "dilemma" is used to refer to a topic on which science and religion make assertions that appear to some people to be incompatible.

The term approach was chosen as a way to describe the way that an individual responds to a science-religion dilemma. Early here it became apparent that analysing students' beliefs alone would not provide an in-depth understanding of their thinking.

Individuals from novice to expert hold a range of religious and scientific beliefs. To understand the depth of thinking it is necessary to look at the reasoning that leads someone to hold a particular belief. This includes, for example, the decision about whether or not to think about the dilemma. The findings that are presented in this thesis focus on how students arrive at their beliefs rather than what their beliefs are. Following the analysis of the students' responses, a typology was devised to describe the main categories of approaches that students took.

1.6 Chapter Summaries

1.6.1 Part 1: Introduction (Chapter 1).

1.6.2 Part 2: The Literature Review (Chapters 2-3):

Chapter 2 describes selected works that discuss the relationship between science and religion with a particular focus on the views of religious scientists Chapter 3 reviews previous research by educational psychologists regarding students' cognitive development and also the literature that currently exists on how students approach science-religion dilemmas.

1.6.3 Part 3: Method and Procedures for the First Empirical Study (Chapters 4-5):

Chapter 4 explains the reasons for believing that a study this kind could provide useful addition to current knowledge. Chapter 5 describes the development of an interview schedule containing three written dilemmas that was then used to interview 20 tertiary-level students. A brief overview of the findings from the interviews is given in Chapter 6.

1.6.4 Part 4: Devising the Interview Analysis Methods (Chapters 7–12):

Chapters 7-12 describe the development of a series of analysis methods designed to study the transcripts in a systematic fashion.

Chapter 7 describes the development of two basic five-fold category systems for students' approaches. The "Free Choice" typology categorised the approaches that students said they took before the interview when they could choose freely how to respond. The "Written Dilemma Approach typology" categorised students' approaches to the three written dilemmas presented in the interviews, in which students were asked to identify apparent contradictions.

Chapter 8 presents the "Written Dilemma approach model" which is a visual way of displaying the major decisions involved in each type of written dilemma approach. Chapter 9 describes a conceptual sequence of ways of thinking about these kinds of dilemmas; Chapter 10 presents the Contradiction-type method of analysis which infers information about students' views of science and religion;

Chapter 11 describes revisions that were made to the Written Dilemma Approach Model; Chapter 12 summarises the steps in the final written dilemma analysis system which is a system of analysis containing the methods described thus far, used in combination. It is claimed that by using the analysis methods within the written dilemma analysis system, it is possible to construct meaningful descriptions of students' approaches.

1.6.5 Part 5: Applying the Analysis Methods in the First Study (Chapters 13-14):

Chapter 13 presents the results of the main analysis system applied to the 20 interviews.

Chapter 14 describes additional findings that emerged during the study.

1.6.6 Part 6: The Second Empirical Study (Chapter 15):

Chapter 15 describes a second study which was carried out with another group of 20 university undergraduates and which employed similar interviewing and analysis methods.

Part 7: Conclusions (Chapter 16):

Chapter 16 presents the conclusions of the research and suggests areas for future research.

PART 2: LITERATURE REVIEW

CHAPTER 2
WAYS OF RELATING SCIENCE AND RELIGION

2.1 Overview of the Literature Review

The three areas of literature which are relevant to this study are:

- The perceived relationship between science and religion, as seen by scientists, religious scientists, philosophers and science historians, historically and currently;
- The application of psychological theory to problems of religious development;
- Interviews and surveys designed to discover school students' and university students' views on the relationship between science and religion.

A discussion of students' views, relating to the second and third points is presented in Chapter 3. Chapter 2 describes how the relationship between science and religion is described in the academic literature. One purpose of the review is to describe existing typologies of ways to approach science-religion dilemmas. The review also discusses the opinions held by selected religious scientists, because one of the purposes of this project is to describe the thinking that underlies their approaches to science-religion dilemmas.

The chapter begins by explaining why particular authors were selected for this review. Section 2.3 contains a brief presentation of the history of the relationship between science and religion. Section 2.4 describes selected typologies that summarise these views of the relationship. Section 2.5 provides more information about the views of the relationship that are contained in these typologies. The kinds of topics that contain apparent contradictions are discussed in Chapter 2.6.

2.2 The Rationales behind the Selection of Publications for this Review

2.2.1 Prominent Authors of Useful Typologies

The following sections present the views of selected scientists, theologians, historians and philosophers who have discussed the relationship between science and religion. These references are provided first, as a point of comparison to indicate how a rational and consistent observer would respond to the issues that arise at the interface of scientific and religious thinking. Later, this will be compared with what the students in this study said on the subject. At the same time, the philosophers provide a sample of views, from what is presumably the most developed part of the population, and can be viewed as the point to which development tends.

Although there are thousands of publications that discuss the relationship between science and religion, the task of deciding which views and typologies of views are important is not as difficult as it might seem because there are some authors in this field whose work is widely cited throughout the literature. These authors include Barbour (1988), Polkinghorne (2000), Peacocke (1979), Drees (1996), Peters (1998) and Gould (1999b). The ideas presented by these authors are reviewed, focussing on how they constructed the typologies that are currently available to categorise ways to approach science-religion dilemmas.

It will be shown that these typologies generally refer to views about the relationship between science and religion as wholes, rather than to the responses that may be made regarding individual topics.

2.2.2 Individual Authors Who Provide Case Studies

2.2.2.1 Religious Scientists

In recent times, a large number of books have appeared in popular bookshops and in academic libraries, written by scientists who argue that science and religion are compatible. Here, these authors are collectively labelled "religious scientists". Together they come from a range of scientific backgrounds including meteorology, cosmology, chemistry, mathematics, biology and physics. The ideas of Berry, a Christian and a biologist will be a particular focus of discussion.

Three particularly well-respected authors are Barbour, Polkinghorne and Peacocke. These individuals are in Polkinghorne's words, "scientist-theologians" – that is, they have left science careers to become theologians (Polkinghorne, 2000, p. 155). Their work is relevant because it provides insights into their own religious viewpoints and also because of the typologies they present of other viewpoints.

2.2.2.2 Atheist scientists

Given the findings of Larson and Witham's survey of 1000 American scientists, we could expect there to be at least as many professional scientists who do not hold a religious faith as there are who do hold a faith (Larson & Witham, 1997, 1998). Even so, atheist scientists have a much smaller presence on library shelves and in the media than the religious scientists. Here, references will be made to the views of Dawkins who is a self-described scientific materialist and atheist (Dawkins, 1998).

2.2.2.3 Agnostics

In addition to those authors who have expressed their opinions that science and religion are compatible or are incompatible, there are a number of well-respected authors in this field such as Gould, who describe themselves as agnostics. There are also authors who do

not express a personal viewpoint, and who describe themselves as science historians and philosophers.

2.3 Historical Perspectives

2.3.1 The Changing Natures of Science and Religion

The relationship between science and religion has been variously described as one of conflict, harmony, independence, conciliation and dialogue (to mention but a few). As Brooke (1991) points out, one of the reasons for this abundance of opinions is that there is not just one view of science and one view of religion which interact. Instead the relationship must be seen as a complex interaction between historically shifting views of religion and similarly shifting views of science. This "plethora of different contexts" (Brooke, 1991, p. 321) produced many of the views of the relationship that are discussed now, including and in particular, the view that science and religion are in conflict.

Academics who write about the relationship between science and religion generally include a section that explains how the current major views of the relationship each arose during a particular period in history. The books by Barbour (1966), Hindmarsh (1968), Ramsey (1964), Peacocke (1979), and Polkinghorne (1998b) are just a few examples. The point of these historical backgrounds is to show that during the last 400 years, the relationship between science and religion has changed not least because science and religion have themselves changed.

In the following paragraphs a brief description will be given of this history and the views that arose. Later it will be explained that the well-respected typologies produced by authors such as Barbour (1988), Polkinghorne (2000) and Drees (1996) are based on organisations of these historical views.

2.3.2 Independence / "The Two Books"

Some accounts of the interaction between science and religion highlight the existence of conflict. Russell (1961) states that it was the perception of conflict between science and religion that stimulated the ancient Greeks to ask questions about the nature of reality.

Other accounts begin in the sixteenth century when the relationship between Christianity and science is said to have been cordial, and when it is said that modern science began (see Berry, 1996; Davies, 1992; Jaki, 1974; Hooykaas, 1972; Peacocke, 1979; Snow, 1998; Whitehead, 1925).

Peacocke (1979) contends that it was a Christian view of the world that led the first scientists to conduct experiments. As Davies (1992) similarly explains, Christians believed that the universe was designed by God which meant that its structure was beautiful but not necessarily logical. The implication of this view was that the most straightforward way to discover how the universe behaves in a given situation was to conduct an experiment.

In this presentation of the history of the relationship, modern science and religion were initially allies. The perceived independence of the fields ensured rapid scientific progress (Worthing, 1996). The perspective of two separate books – one of "God's works" and one of "God's word" – meant that scientists could freely investigate the physical world without fear of inadvertently offending those who were concerned with theological matters (Peacocke, 1979, p. 3).

Peacocke (1979) explains that since the two books of the universe were both believed to have been written by the same author, it was generally assumed that the ideas within these books would be in harmony. It was an assumption that proved overoptimistic.

2.3.3 The Galileo Affair

The history of the relationship between science and religion includes two infamous occasions of conflict, the first of which took place in 1633 when the Vatican took Galileo

to trial. In the views of many religious scientists, the media have overly stressed what Polkinghorne (1998b) describes as "the Galileo affair" (p. 6). Drees (1996) also describes the event as the "Galileo affair" and proposes that it is the "prime myth of conflict between science and the Catholic Church" (p. 63).

The cause of the conflict was nominally a difference of opinion regarding the true meanings of Biblical references to an Earth-centred universe. The view of the Catholic Church in the seventeenth century was that these references should be understood literally. Rossiter (1996) makes the point that until someone produced an alternative account, there was no compelling reason why accounts in Genesis could not be interpreted literally. On the basis of the evidence he said he saw in the night sky, Galileo argued that the Copernican model was more correct and that the Bible should not be read literally on this issue (Polkinghorne, 1998b). The Vatican ruled that this challenge to doctrine was unacceptable. Under pressure, Galileo announced that he had made a mistake. Polkinghorne concludes his account by saying that Galileo's model of the solar system is now almost universally accepted and that the Church has a revised theology that embraces it (Polkinghorne, 1998b).

2.3.4 God of the Gaps

Newton, like many scientists in the seventeenth century, believed that science and religion were compatible, and wrote as much on several occasions (McLachlan, 1950). It is said that Pascal, Boyle and Ray were also motivated by their religious faith to carry out their research (Berry, 1996; Coulson, 1968; Hummel, 1986).

Newton combined scientific and religious explanations to propose that acts of God were responsible for the mysteries that his scientific theories could not explain. When the observed orbits of the planets could not be fully explained using the equations scientists were working with, Newton's conclusion was that God made routine adjustments to the planets to keep them in orbit (Polkinghorne, 2000).

As many individuals have since pointed out, the dilemma that was faced by supporters of the "God of the Gaps" approach was that as the gaps in the theories were gradually filled, God's role became smaller (Peacocke, 1979).

2.3.5 A Second Challenge and the Conflict View

In the nineteenth century, science produced a second major challenge to religion. At the time, and for many people today, Darwin's theory of evolution appeared to oppose the very idea of God's existence (Birkett, 1997; Draper, 1898; Durant, 1985; Peters, 1998; Polkinghorne, 1998b). Russell (1961) asserts that if evolution is to be believed then humans are merely "the outcome of accidental collocations of atoms" (p. 41) and we must accept that:

> all the inspiration, all the noonday brightness of the human genius, are destined to extinction in the vast death of the solar system, and that the whole temple of Man's achievement must inevitably be buried beneath the debris of a universe in ruins – all these things, if not quite beyond dispute, are yet so nearly certain that no philosophy which rejects them can hope to stand. (p. 41)

The debates that took place in the nineteenth century between scientists and theologians regarding evolution have been well publicised. The most infamous is a debate between Huxley and Wilberforce which Ramsey (1964) describes in this colourful way:

> It is just over a century ago since the notorious meeting of the British Association in the Science Museum at Oxford which saw the unedifying spectacle of Bishop Wilberforce taunting T.H. Huxley by asking, with what we are told was a smiling insolence, whether it was through his grandfather or his grandmother that he claimed his descent from a monkey. (p. 1)

As Hindmarsh (1968) explains, this was the time when metaphors of conflict and warfare were first employed by the media to describe the relationship between science and religion, causing the public's overall perception of the relationship to swing towards conflict.

Many religious scientists argue that the periods of conflict in the history of the relationship receive unwarranted media attention. The result, they say, is that the perception of conflict not only became established in the public's mind in the nineteenth century but also continues to be the dominant view today (Barbour, 1997; Berry, 1996; Chapman, 1999; Coulson 1968; Gilkey, 1985; Haught, 1995; Jaki, 1978; Murphy, 1990; Peacocke, 1971; Peters, 1998; Polkinghorne, 1998b).

2.3.6 Rapprochement / Consonance / New Synthesis

Recently the press has switched from a preoccupation with conflict to the heralding of a rapprochement between scientists and religious leaders (Chapman, 1999; Scott, 1999). In the *New York Times,* Johnson (1998) declared that there is a new desire for common ground and a revival of the hope for reconciliation. In the same year, the cover of *Newsweek* claimed, "Science Finds God". Inside, the magazine described a conference entitled "Science and the Spiritual Quest" and reported that most of the several hundred scientists and theologians at the meeting supported the claim that science and religion are now converging (Begley, 1998).

In parallel with reports about such events, hundreds of scientists, including physicists, mathematicians, biologists, chemists, evolutionary biologists, sociologists and engineers, have written publications for laypeople arguing that belief in God is possible in a scientific age (Ashton, 2001). Peters describes it as a "revolution" led by an "astounding intellectual trend" (Peters, 1996, p. 323).

Several organisations offer programs and incentives to scientists to encourage them to engage in discussion about the interaction between science and religion. The John Templeton Foundation in Pennsylvania awards an annual prize of $1.24 million dollars each year to one individual for his or her contribution to progress in religion. Davies, Barbour and Polkinghorne have each won this prestigious prize.

Since 1995, the American Association for the Advancement of Science (AAAS) has run programs that, according to its authorised website, seek to "increase the engagement of scientific communities in the dialogue on science, ethics, and religion" (AAAS, 2001).

In 1988, the Catholic Church offered scientists and theologians a forum for dialogue at a conference to look at the relationships between physics, religion and philosophy. In his opening speech Pope John Paul II welcomed "a definite, though still fragile and provisional, movement towards a new and more nuanced interchange" (John Paul II, 1988, p. M4).

The picture presented by these publications and speeches is of scientists and theologians working together on a view of reality that combines religious and scientific principles, with many of them confident that science and religion can operate in harmony. The media's description of the change of mood as sudden and dramatic has raised the public's interest in the area (Easterbrook, 1999). To meet the new demand for knowledge, increasing numbers of universities have initiated courses for students who want to study science and religion (Chapman, 1999).

2.3.7 What Remains of the Conflict View

Although in the last 30 years a huge number of texts have been published expounding the view that science and religion are compatible, it does not necessarily follow that more scientists are now religious. It may alternatively be that the scientists who argue for the harmonious view are becoming more adept at getting their opinions heard.

In a survey undertaken in 1914, 1,000 randomly selected US scientists were asked whether they believed in God. The results revealed that almost 90 years ago, 42% of the scientists who responded said they believed in God (Leuba, 1916).

Nineteen years later, Leuba repeated his study and reported that the percentage of scientists in the general group who expressed a belief in God had fallen from 42 to 33 (Leuba, 1934, as cited in Larson & Witham, 1998).

In 1996, Larson & Witham (1997) used Leuba's survey to test the religious faith of the scientific community in more recent times. They reported that 40% of the scientists who responded to their survey expressed a belief in God, a percentage which compares closely with Leuba's findings of 1914. Larson and Witham concluded that scientists are no less religious than were their counterparts nearly 90 years previously.

In a second survey, Larson and Witham (1998) focussed on the views of America's more elite scientists, which was another aspect of this issue that Leuba had investigated. Leuba (1916) stated that the percentage of elite scientists who expressed a belief in God in 1914 was 28%. Almost 90 years on, Larson and Witham found that the percentage had dropped to seven. They conclude that, "among the top natural scientists, disbelief is greater than ever - almost total" (Larson & Witham, 1998, p. 313).

Writing in *The Skeptic magazine*, Shermer (1998), looked at the likelihood of a belief in God among different professions. He reported that among the American general public, the likelihood of believing in God was just over 90%; the percentage for scientists was almost 40; for biologists it was just under 30 and for physicists it was just over 20.

These finding can be compared with the findings of a survey of American science teachers. Among American science teachers in general, the percentage who supported a non-theistic view of how life began and evolved was found to be about 54; among biology teachers, support of the modern theory of evolution was higher, at almost 70% (Tatina, 1989). When it is remembered that the first of these surveys looked at the percentage of people who believed in God, while the second looked at the percentages who do not believe in God, the findings are comparable. What is shown in general by surveys of this kind is that belief in God among scientists and those who work in science-related professions is considerably lower than among the general public.

Wuthnow (1988, p. 301) summarises these findings when he says that scientists in general "demonstrate radically low levels of religious commitment". It is his view that this is because of the nature of thinking scientifically and that: "scientific and social scientific meaning systems also appear to operate as functional alternatives to traditional theistic ideas for a number of people" (Wuthnow, 1988, p. 302).

2.4 Typologies of Views

2.4.1 Introduction

Today, there is still no universally agreed view of the relationship between science and religion. Instead there is a plethora of different opinions many of which are related to the views that were described in the previous section.

This part of the literature review gives an overview of the views that exist among scientists and theologians today. The section begins with a review of the typologies of current views produced by Barbour (1988), Polkinghorne (1998b), Peters (1998), Drees (1996), and Haught (1995).

2.4.2 Barbour's Typology

Barbour's "useful classification" was published in the 1960s and is widely acclaimed to be the first comprehensive typology to describe historical and current views of the relationship between science and religion (Polkinghorne, 1998b, p. 20). It was taken as the starting point for many if not all of the major typologies that followed (Drees, 1996; Peacocke, 1971; Peters, 1998). The typology has four categories: conflict, independence, dialogue and integration. The details of these categories are as follows:

- Conflict: The view that science and religion are mutually exclusive. Subtypes are Biblical Literalism and Scientific Materialism.

- Independence: The view that science and religion are complementary but very different ways of thinking. Beliefs drawn from one domain cannot interact with beliefs drawn from the other. This view is also called the "Two-Worlds" and "two books" view.

- Dialogue: The view that science and religion investigate similar questions, using some of the same methods. Therefore meaningful dialogue between the two disciplines is possible. This category can overlap and lead to Integration.

- Integration: The view that science and religion can approach questions about the natural world and about the divine in completely synergistic ways.

2.4.3 Peters' Typology

Peters (1998) produced an eight-fold typology, which adds detail to Barbour's basic four-fold scheme. Peters included, for example, a category called ecclesiastical authoritarianism which refers to the view proposed by the Catholic Church until the 1960s that the Church's ruling on any apparent contradiction is final. Referring to more recent attempts to fuse science and spirituality, there is also a category headed New Age spirituality.

2.4.4 Drees' Typology

Drees (1996) observed that science and religion provide us with more than assertions about facts and consequently, do not only interact as sources of knowledge. Drees warned that Barbour's system only encompasses the relationship between the content within each discipline.

To remedy this shortfall, Drees set out a nine-fold system in which other kinds of interaction were also considered. Within religion Drees added headings for religious experience and religious tradition. He also claimed that additional challenges from science may arise from new views of knowledge and new appreciations of the world (Drees, 1996, p. 45). Since my research focuses on differences in religious and scientific content, Drees's expansion does not need to be considered further in this work.

2.4.5 Haught's Typology

Haught (1995) presented another four-fold typology, which is:

- Conflict - this category is similar to Barbour's category of conflict. It is the view that science and religion are irreconcilable;
- Contrast – this category is similar in meaning to Barbour's category of "independence". It is the view that there can be no real conflict since religion and science address quite different questions;
- Contact - this category is similar in meaning to Barbour's category of "dialogue". It is an approach that looks for dialogue and interaction between science and religion;
- Confirmation – this is the view that at a deep level, religion supports science.

Another important typology is the one produced by Polkinghorne (1998b) which will be described in Chapter 2.5.5.

2.4.6 General comments

A brief review of the literature revealed that there are now a large number of proposed category systems, each with slightly different, but frequently overlapping, criteria and purposes. The categories in these typologies include conflict (Barbour, 1968); assimilation (Barbour, 1988); integration (Pilkington, 1960); synthesis (Coulson, 1955; Ramsey, 1964); consonance (Peters, 1989); conciliation (Polkinghorne, 1996); accommodation (Polkinghorne, 1998a); dialogue (Barbour, 1988); conversation (Haught, 1995); independence (Polkinghorne, 1998b) and natural theology (Barbour, 1968). The existence of these other views indicates that since Barbour's original system, debate over a suitable typology for the views of academics has proceeded and has produced a number of variations on Barbour's original scheme.

In keeping with the aim for this study, these typologies were reviewed to discover whether they could be used to categorise the range of views that might be expressed by tertiary level students.

As it turns out, the typologies are unsuitable for several reasons. Firstly most of the typologies do not seek to describe the full range of stances that might be taken, focussing instead on those that have been prominent in history. This methodology of surveying the past produces only a "selective and limited" sample of possible approaches (Drees, 1996, p. 5).

Secondly, as a result of the way they were produced, the categories within the typologies are thematic rather than systematic. Authors themselves warn readers that the boundaries may in some cases overlap (Barbour, 1988; Drees, 1996).

Barbour, for example, explains that: "Particular authors may not fall neatly under one heading... The dialogue viewpoint, in particular, may be combined with either Independence or Integration themes" (Barbour, 1988, p. 21).

A third difficulty which will be explained in more detail in Chapter 4 was that these categories were designed to describe views of the relationship between science and religion as wholes. The methodology that was adopted in this current research project was to look at how individuals approach topics that are addressed by science and religion.

2.5 Individual Views

This section describes selected views of the relationship and the views of science and religion that interact to form those views of the relationship. The first view given here is the view of Deism-Determinacy. This is followed by a discussion of the conflict view, which was featured in all of the typologies described previously.

2.5.1 Deism and Determinacy

Newton described a universe that was mechanical and predictable. Equations for forces and motion seemed to describe how objects move. This idea led to the view of Determinacy, which Polkinghorne (1998a) explains is the view that the path and fate of the universe are fixed and knowable. In a similar way Murphy (1989) describes Determinacy as the view that "the world must roll along its determined or statistically regular course" (p. 237).

This scientific perspective had an impact on the way that supporters saw God's relationship with the universe. Determinacy was incompatible with the idea that God continuously interacts with events. Instead, in the minds of many religious scientists in Newton's time, God was seen as a Creator, but not as a current force. The idea of a scientifically predictable universe combined with the idea of a Passive Creator God led to the view of Deism.

2.5.2 The Conflict View

The historical context in which the conflict view first arose has already been described. In this section, it is the particular views of science and religion that combine to produce this view that are under scrutiny. Barbour (1966) proposes that there are two viewpoints that lead to the belief that science and religion are in conflict, and these are Scientific Materialism and Biblical Literalism. Although Barbour does not seem to say this himself, I suggest that a perception of conflict would follow if an individual held either or both of these belief systems.

2.5.2.1 Conflict: Scientific Materialism

Barbour explains that Scientism or Scientific Materialism makes two assertions (1) that the scientific method is the only reliable path to knowledge, (2) that matter and energy are the only realities in the universe. Dawkins (1995) who describes himself as an

evolutionary biologist and atheist agrees, adding that physical evidence is in his view the critical factor when deciding what to believe:

> Science shares with religion the claim that it answers deep questions about origins, the nature of life, and the cosmos, but there the resemblance ends. Scientific beliefs are supported by evidence, and they get results. Myths and faiths are not and do not. (p. 33)

2.5.2.2 Conflict: Biblical Literalism

Another group who contend that science and religion conflict are supporters of Biblical Literalism. Members of this group believe that the descriptions of the universe given in the Bible are physically accurate. Some supporters of these claims have proposed "Creation Science" which is alleged by its supporters to be an alternative science that is compatible with a literal interpretation of the timeline described in the Bible. For example, Young Earth Creationists believe that the universe began 6,000 to 10,000 years ago and denounce conventional scientific descriptions of the evolution of the universe and life (Numbers, 1993).

Barbour concludes his section on this view by saying that: "Scriptural literalism is no longer a major issue between science and religion" (Barbour, 1966, p. 5).

2.5.3 Harmony / Complementary / Two books / Independence

The metaphor of two books – first proposed by Bacon – is still current in today's discussions of the relationship between science and religion.

Gould, an Agnostic and palaeontologist, expressed the view that both science and religion have useful information to offer, thus: "To cite the old clichés, science gets the age of rocks, and religion the rock of ages; science studies how the heavens go, religion how to go to heaven" (Gould, 1999b, p. 6).

Haught (a meteorologist) made a similar point, saying that: "science is about causes, religion about meaning" (Haught, 1995, p. 15). This approach differs from "God of the Gaps" in that God is not placed in the spaces within the scientific explanation. Instead it is said to have a different language or a different function (Barbour, 1988).

Houghton described the complementary natures of science and religion thus: "They are views from different perspectives and told largely in different language" (Houghton, 1995a, p. 61). Houghton (1995a) wrote that to find God:

> one way is to look into the 'scientific story' and see God's thoughts. Another way I will call the 'faith story': the description and interpretation of events when viewed with the 'eye of faith' – in other words, in the context of a relationship with God. (p. 60)

A question that is discussed by supporters of the harmony view is whether science and religion are independent, or whether they are mutually supporting. Gould was of the opinion that the two fields occupy exclusive domains, which he termed "Magisteria" (Gould, 1999b, p. 5). In cases of apparent contradiction between the two realms, he called for non-interference, saying that since science and religion are independent, it is not logical to read a scripture like a scientific text, or to attempt to disprove religious beliefs using scientific methods (Gould, 1999b, p.93).

He supported, for example, the teaching in schools of the theory of evolution, and said that this is a prime example of an occasion when religion and science should be held separate: "Science and religion should be equal, mutually respecting partners, each the master of its own domain and with each domain vital to human life in a different way" (Gould, 1999a, p. 59).

Houghton (1995a) also expressed the opinion that there can be no real contradictions between science and religion. Houghton's paper does not address specific examples of apparent contradictions. Instead it is stated with confidence that, God is "clever enough to ensure at the same time consistency in the 'scientific story' and consistency and significance in the 'faith story'" (Houghton, 1995a, p. 91).

MacKay (1974) also expresses the view that science and religion have different roles, stating that cosmology is relatively well equipped to answer questions about how the universe came about while Christianity can address questions about why the universe came about.

It seems, however, that when it comes to how to respond to apparent contradictions and how to explain why they are not real, the view of Independence does not always provide clear instruction. A careful search of several texts reveals only a few illustrations of how these authors believe they can achieve their aim of offering us two complementary and non-competing sets of truths. Gould (1997) explained that the apparent contradictions are removed by insisting that religion can never offer scientific information, and science can never offer spiritual or ethical information. It is a division that Gould himself admitted is sometimes difficult to make in practice (Gould, 1997). Barbour makes a similar point: "We do not experience life as neatly divided into separate compartments; we experience it in wholeness and interconnectedness before we develop particular disciplines to study different aspects of it" (Barbour, 1997, p. 89).

MacKay (1974) expresses the view that separating science and religion into distinct and exclusive domains is an artificial process. He argues that assertions made by science and religion should be compared in order to hone and support the content of each in the light of the other. MacKay also warns that, although on many instances these comparisons will show that the scientific and religious statements are compatible, on other occasions we must be prepared for the discovery that there is conflict with the implication that that one view is wrong in its existing form.

2.5.4 The Remaining Categories in Barbour's system

Most typologies include the headings conflict and independence (or different terms meaning much the same thing.) Once the views that fit these categories are in place, authors must then decide how to categorise the views that remain.

2.5.4.1 Dialogue

The third category in Barbour's system is "Dialogue" (Barbour, 1988), which is an approach illustrated by the following words of Pope John Paul II: "As dialogue and common searching continue, there will be growth towards mutual understanding and a gradual uncovering of common concerns which will provide the basis for future research and discussion" (John Paul II, 1988, p. M6).

Thus dialogue is a relationship that requires only a passive sharing of ideas. It does not insist on a piece-by-piece merger of science and religion. Other activities associated with dialogue are discussions about the connections between the beginnings of modern science and Judeo-Christian traditions. The definition is relatively vague, however, and as Barbour himself acknowledges, this category overlaps with integration (Barbour, 1988).

2.5.4.2 Integration

The product of Integration is a single discourse (Polkinghorne, 1998b). This could be in the form of a theology of nature or a synthesis. Barbour - who himself supports integration – explains that:

> This combined narrative starts from a religious tradition based on religious experience and historical revelation. But it holds that some traditional doctrines need to be reformulated in the light of current science.
>
> (Barbour, 1988, p. 41)

Hawthorne (1986) agrees that the Bible was not intended to seen as a scientific textbook and that its words need to be "interpreted correctly" (p. 25).

Berry describes himself as a "Christian biologist" (1996, p. vii) and also advocates updating religious beliefs to obtain a better fit with accepted science. In Berry's opinion, Biblical texts "should not be read as scientific accounts" and were not written to be read literally (p. 41). In Berry's view there are no conflicts between "real science" and "real faith" (p. vii).

2.5.5 Polkinghorne's System

The typology produced by Polkinghorne (1998b) has four categories which are: conflict, independence, consonance and assimilation. Polkinghorne explains that these labels indicate the extent to which religion is required to be "reformulated" to fit with science by supporters of each approach (Polkinghorne, 1998b p. 22). At one end of the spectrum is Consonance – a view that says that the traditional beliefs of science and religion should be treated with equal respect, while at the other extreme, there is assimilation, which requires the immediate correction of religion to fit with accepted science. In this way, Polkinghorne argues that his own approach which he describes as Consonance is not the same as the approach of Assimilation (Polkinghorne, 1996, 1998a).

2.5.5.1 Assimilation

Polkinghorne (1998a) describes Peacocke's approach as Assimilation. In his own description of his beliefs, Peacocke (2001) says he is a theist, who sees the Big Bang and the process of evolution as illustrations of how the Creator God creates. Peacocke also argues that ancient faith is required to change in the light of scientific proof.

Polkinghorne (1996) maintains that in their haste to reconcile science and religion, supporters of Assimilation insist that several cherished religious beliefs must be reformulated if they are found to be incompatible with accepted science. By way of example, Polkinghorne says that the Assimilationist's view is that Jesus Christ is not divine but is instead "the pioneer of what humanity can become under the guidance of divine inspiration" (Polkinghorne, 1998a, p. 86).

In the example below, Berry (1996) arguably takes the approach of Assimilation when he reformulates the Biblical account of Adam and Eve in order to obtain a better fit with science:

> Genesis 2:21 tells us that Eve was formed from Adam's side. If God is truly omnipotent, clearly he could have made Eve from one of Adam's ribs, but that does not mean that he actually did so ... It is fully consonant with Genesis that God created Adam in the body of a Near Eastern farmer comparatively recently in archaeological terms. (p. 50)

Davies (1992) similarly expresses the view that traditional religious views should be modified where necessary to make them compatible with what we know from science. Thus, when Davies contemplates the nature of God, he does so while mindful of the views of modern physics. The God that Davies believes in is drawn from his studies of mathematics and physics, rather than from a reading of the Bible. Davies rejects the idea of a God who works miracles, preferring to believe that the laws of physics apply universally and continuously (Davies, 1995). As a result, Davies' view of God is not one that "bears much relation to the personal God of religion, still less to the God of the Bible or the Koran" (Davies, 1992, p. 191).

Barnes, a Bishop and mathematician, could be considered to be an early Assimilationist. This controversial religious leader argued in 1948 that to preserve the integrity of science, it is necessary to disregard Biblical accounts of miraculous events including the Virgin birth and Jesus' resurrection.

While some Christians may feel that these reformulations are unacceptably severe, others may be reassured to hear in some scientists' opinions, there are arguably essential religious beliefs that remain tenable with the simultaneous acceptance of what is often described as irrefutable scientific fact.

Perhaps it is for this reason that Davies and Peacocke (as well as Barbour and Polkinghorne) have each been awarded the prestigious and lucrative Templeton prize which is awarded annually for "progress" in religion.

2.5.5.2 Deciding Whether To reformulate A Religious Belief

On finding an apparent contradiction between science and religion, the Assimilationist is required to make a subjective decision as to whether to reformulate the religious assertion. As Barbour observes, not every scientific theory that is published stands up to rigorous testing, so clearly it would be absurd to update religion each time a new theory is proposed. Barbour explains that:

> The theologian will want to draw mainly from broad features of science which are widely accepted rather than risk adapting to limited or speculative theories which are more likely to be abandoned in the future.
>
> (Barbour, 1988, p. 41).

Polkinghorne makes the same point with a striking metaphor, saying that, "a theology that marries the science of today may well be a widow tomorrow (Polkinghorne, 1986, p. 10).

Secondly, the Assimilationist must be confident that each reformulation of religion is acceptable. Berry asserts that Adam could have been a near Eastern farmer. Another Christian may feel that this is too great a departure from the account given in the Bible.

2.5.5.3 Consonance

The word "Consonance" was first coined as a way to describe the relationship between science and religion by McMullin (1981). It was then adopted by Peters (1998) and Polkinghorne (1998b) as appropriate labels for their own views. Polkinghorne explains that as a supporter of consonance, he seeks "appropriate reconciliation" and that science and religion must "fit together without strain" (Polkinghorne, 1998b, p. 22).

It is pertinent, then, to look at the way in which the holder of such a view responds when a religious belief is challenged by science. Polkinghorne insists that in such cases, theology is as entitled as science to retain traditional categories even if they appear to be counterintuitive (Polkinghorne, 1998a). He gives few examples to illustrate how this might work in practice. In the excerpt below, Polkinghorne is discussing the issue of

predestination versus Free Choice will. He explains that science seems to show that our perception of "Free Choice will" is an illusion and that our behaviour is dictated by the way our brains respond to the environment. He observes that this picture is incompatible with the biblical view, and advises that in this case, it would be imprudent to rush to reformulate the Biblical view:

> Until we know better how to integrate them let us at least hold fast to our basic personal experience of choice and responsibility without denying the neurological insight that our mental activity is incarnated in our brains. These are complementary aspects of the whole person, just as wave and particle are complementary aspects of light.
>
> (Polkinghorne, 1986, p. 96)

On some topics, this reconciliation appears relatively easy to achieve but other areas are more problematic. Scientific and religious descriptions of the end of the universe are described as "dissonant" rather than consonant (Peters, 1997, p. 662).

Polkinghorne's explanation for why it is reasonable to reformulate science as well as religion is given in more detail in the Section of this thesis that talks about divine action (Chapter 4). In overview, Polkinghorne states that miracles are not occasions on which scientific laws are "broken", but may instead be special occasions on which the usual scientific laws do not apply.

In practice, the approach often seems to take the path of Assimilation, in that many more religious assertions are reformulated than scientific ones (Drees, 1996).

Figure 1 shows diagrammatically the different category systems suggested by Barbour and Polkinghorne.

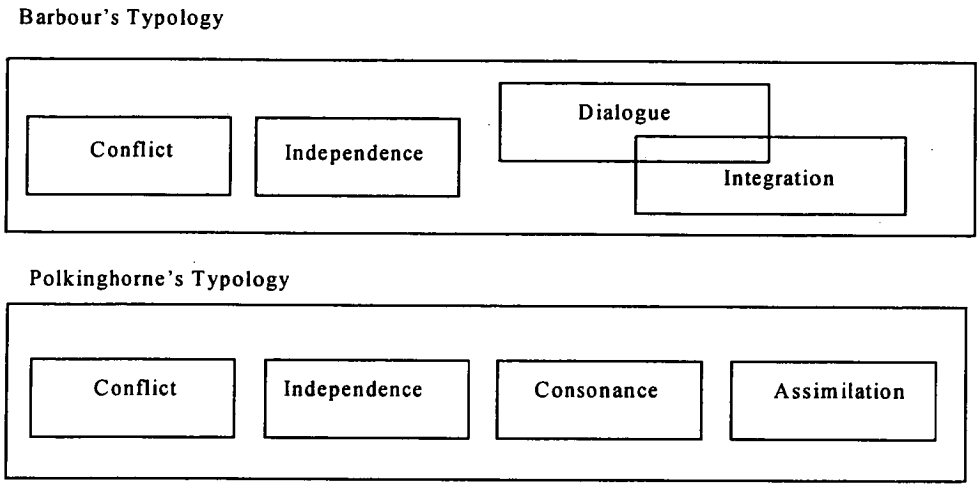

Figure 1. Typologies devised by Barbour and Polkinghorne

2.5.6 Views Describing One Aspect of the Relationship

As previously discussed, many scientists, theologians and philosophers have set out their views about the relationship between science and religion. The previous views are ones that attempt to describe the relationship as a whole. There are several other views that focus on a particular aspect of the interaction. Three will be described here.

2.5.6.1 Scientific Theology

As Duce explains, although many people focus on the occasions on which science and religion make claims that appear to be contradictory, there are other occasions on which science and religion are "consistent" and also occasions when they are "non-interacting" (Duce, 1998, p. 71). Some of the prominent viewpoints in the literature focus on these other aspects of the interaction.

Scientific theology is based on the observation that the universe has qualities that are so beautiful and unusual, it seems difficult to imagine that they could have arisen by blind

chance. For Aquinas, these features included the eye and the beauty of the world (Aquinas, 13th century).

Paley (1802) supported this argument and offered the following analogy. Suppose you found a watch found lying in a field, you would, on inspection, decide that the watch has been designed by a watchmaker and is not a random assembly of parts. Using this analogy Paley then argued that the world exhibits complexity and on this basis, that there must be a designer of the world, God.

Modern proponents of natural theology also admire the apparent fine tuning of universal physical constants to suit life, together with the intelligibility of the universe to our inquiry (Polkinghorne, 1998b, p. 72) Thus scientific theology makes a positive connection between the miraculous nature of our surroundings and the idea that God designed the universe. It is not a view, however, that explains or even addresses apparent contradictions.

There is an expanded version of this view, which is termed the "affective view" and which is described by Schneller (1982). Holders of the affective view claim that since we can be certain that God exists (by the argument of design) we can also be certain that there are no contradictions between science and religion.

2.6 Contradictions

The views described in the preceding sections have described the relationship between science and religion in general, without focussing on any individual topic. The methodology that was used in this research was to ask tertiary level students to talk about topics on which science and religion appear to make contradictory claims. There are many references to these dilemmas in the literature, and examples of different ways to address them. The topics selected for this research have already been mentioned in this review. They are Adam and Eve versus evolution; the Creation versus the Big Bang and also the effectiveness of prayer.

The literature also contains useful overviews of the ways in which contradictions arise. These are discussed in this section.

2.6.1 Three Categories of Contradictions

Poole (1985) suggests that there are three different categories into which contradictions can be placed:

1) The data of science: There are differences between the factual contents of the two disciplines. For example, the period of creation took 6 days according to the Bible but took millions of years according to scientific theory. Poole asserts that these kinds of discrepancies can often be removed by looking for allegorical rather than literal views of the Biblical text. When Poole uses the word "fact" here, he uses it to signify a proposed item of data or information, the truth of which may be contested. "Fact" here does not mean a "proven" or "accepted" statement. This distinction is self-evident since if the statements made by either science or religion were "facts" (in the sense that they are accepted beyond doubt) then there would be no debate. In this thesis the word, "assertion" will be used in place of the word "fact".

2) The nature of science and religion and the implications for divine action: Science and religion appear to give alternative physical descriptions of how the universe operates.

3) Applications of science: applications of science such as genetic engineering offer us the power to make changes in areas traditionally assumed to be controlled by God.

Concerns about the applications of science are not discussed in this project, which focuses on the differences between the contents of science and religion. The issue of divine action is discussed in section 2.6.2.

2.6.2 Divine Action

The question of how God interacts with the universe is said to be a "central theme" in modern discussions about science and religion (Drees, 1996, p. 93). Davies (1983) agrees that the issue of divine action is recurrent when discussing topics such as how and why life and the universe exist. Questions such as whether life is here by chance, whether prayers can be answered and whether God can work miracles, are all related to the question of how God can influence events in the universe. As Berry explains, "the underlying question is still 'Where does God fit into scientific knowledge and understanding?' – if indeed he does fit" (Berry, 1996, p. viii).

In this thesis, an analysis method will be developed that looks at how individuals respond to each of three different types of divine action. These different types of divine action are ones that are described in the academic literature and which are described in detail by Polkinghorne (1998a, 1990). One of these three types is divine creation.

2.6.2.1 Divine Creation

The least problematic form of divine action for scientists seems to be the idea that God created the Universe. For some people, this is the only kind of divine action that is scientifically acceptable. In their opinions, since the time of the Creation, God has watched the universe develop naturally and has not interfered with the natural course of fate. For supporters of this approach, religion offers little or no scientific challenge and science and religion are said to be compatible.

One particular version of this view is Deism. Deism became prominent just after Newton's time when the mechanistic nature of the universe was most apparent. At that time, it appeared that the universe was set to run a course that could be completely described scientifically. The only role for God was a creative role, which was called the "deistic creation". A remote and passive watchmaker may not have been an attractive vision for believers, but given science's portrayal of a deterministic, mechanical universe, it seemed unavoidable. In his 1990 J.K.Russell Fellowship Lecture, Polkinghorne

observes that an early edition of the Church of England Prayer Book published in 1928 contained a prayer asking for good weather for farming. A later edition, published in 1980, no longer asked God to send us good weather, and instead, gave Him thanks for the good weather we enjoyed in the past. Polkinghorne says:

> Now, I'm not quite clear that it's sensible to be thankful afterwards for what you didn't think it was sensible to ask for beforehand, but I think we must recognize that the advance of science has, in many peoples' minds, diminished the approach that God does anything in particular in the world. (p. 10)

In general, as Murphy (1989) explains, since Deists believe that God does not interact with events in an ongoing way, it follows that "the world must roll along its determined or statistically regular course" (p. 237). The result of this view, states Murphy, is that prayers can be a source of mental comfort only.

Perhaps ironically, some people claim that whether or not divine action is a possibility, praying may restore health, because of a placebo effect that is similar to taking a "sugar pill" (Myers, 2000, p. 95). There are scientists who have studied these effects, and have announced for example, that people who pray live longer (Koenig, McCullough & Larson, 2001). In these instances, there is no violation of natural law because the causes and effects are natural and no miraculous intervention has taken place.

2.6.2.2 Discrete Theistic Action

As discussed previously, there are many scientists today who claim that God does intervene with events continuously and currently. These individuals are supporters of what will be called "theistic action" in this thesis. Theism is the belief in a personal God who responds to prayers and who is continuously interacting with His Creation. There are different kinds of Theistic Intervention. One kind is hidden or what I will call discrete, and the other kind is miraculous.

The idea of discrete theistic action is one that appeals to many religious scientists (Barbour, 1990; Berry, 1996; Coulson, 1968; Drees, 1990; Haught, 1984; Houghton, 1995a; Jaki, 1978b, MacKay, 1974; Peacocke, 1996; Penrose, 1989; Peters, 1989; Polkinghorne, 1998a; Wiles, 1986). Modern theories of particle physics now propose that at a subatomic scale, the "laws" of nature are not deterministic, but probabilistic. Religious scientists point to this change, saying that it means we can have the best of both worlds. They explain that God could theoretically manipulate the outcomes of quantum events, which individually we cannot detect. This means God could guide the fate of the universe "from the bottom up" without violating natural laws (Peacocke, 1990; Polkinghorne, 1984).

In addition to quantum manipulation, there are a number of other mechanisms by which modern religious scientists claim God could intervene with events. Houghton asserts that if God can operate outside time, He could act in the past to create the circumstances that produce a result that someone prays for now (Houghton, 1995b).

Davies, who is also "committed to the notion of a creative cosmos", asserts another view of reality which seems to be closer to Deism (Davies, 1992, p. 191). Davies argues that God designed a universe in which chance can produce "new forms and systems" (p. 192). In Davies' view, novelty arises without divine intervention and God does not intervene with the course that the universe naturally takes.

"Process Theology" is also a view that holds that God has no master plan and does not know the future (Cobb and Griffin, 1977). In this view, chance plays a large role, and God constantly readjusts his will to guide the world towards a future that is not determined.

2.6.2.3 Miraculous Theistic Action

Hume (1993) defines a miracle as a one-off transgression of natural law. In turn, natural laws are built up through our experience that some things happen all the time in the world (Hume, 1975). He regards miracles as the way that a particular religious system seeks to

show its superiority (or truthfulness) above other systems (Gaskin, 1988). For example, Jesus' miracle of healing the paralysed man (Luke 5: 17-26) is intended to demonstrate that he has authority to forgive sins (v. 24) and his resurrection is intended to support the claim that he has a special relationship with God (Acts 2: 14-36). Hume adds that religions like Christianity go on to claim that their miracles are genuine but that miracles attributed to other deities are false. In Hume's view, there can never be sufficient evidence to conclusively prove to a skeptic that a miracle is genuine (Hume, 1975).

Peacocke (1990) also defines miracles as events in which natural laws are broken. Polkinghorne (1998a) stands apart from many of his colleagues by arguing that although natural laws are mostly unbroken, there are some special occasions on which God appears to break a natural law in order to draw our attention to a particular event. The virgin birth is an example that he gives of an apparently miraculous event that he would claim really took place.

Polkinghorne's view is that these apparent miracles are not scientifically impossible events; they are just very rare. Polkinghorne uses the analogy of water in a kettle coming to the boil. If you were to measure the temperature of the water, you would observe it rising steadily,

> and then something happens which, if you haven't seen it happen every day, would absolutely astonish you. That regular rise suddenly stops and something totally unexpected happens: a small quantity of liquid then changes into a large quantity of steam. It's what physicists call a phase change. (1990, p. 14)

Polkinghorne (1998a) proposes that God created a provision for occasional miraculous events within His original design for the universe, which Polkinghorne refers to as the deistic creation. He adds that miracles are only rarely seen because the circumstances that lead to them are unique or at least extremely rare.

In this way, Polkinghorne expands the idea of a deistic creation to argue that it is scientifically acceptable to believe that God responds to prayers.

2.6.2.4 Summary of Views Regarding Divine Action

In this section it has been shown that the nature of divine action is not agreed, even among religious scientists. Polkinghorne (1989) describes a personal God who can respond to prayer and who can act miraculously. Davies (1992) describes God's role as an interested observer, watching the twists and turns that His Creation takes. Somewhere in the middle, Peacocke (1990) sees God as guiding events imperceptibly, perhaps using the mechanisms that modern physics have revealed.

2.6.3 The Nature of Science

In the face of apparent contradictions between science and religion, one response might be to say that science presents a stronger case because it has evidence to support its claim. These days, however, the nature of science and in particular, its infallibility is open to debate.

An important issue within the debate is the extent to which scientists' ideas about the world are objective. Those who argue that scientific knowledge is not formed objectively say that scientists' ideas are shaped by the social context in which they work.

In his avocation for a hypothetico-deductive model of science, Popper (1958) directed scientists to use observation to test their theories. He argued that sensory perception is more objective and therefore reliable than taking things on trust, or having faith. For observations to be credible, scientists need to work without preconceptions about what is happening and why it happens.

Polyani (1958) argues, however, that the process of making observations can never be fully objective and that the interpretation of what we observe always depends on the theories we already hold.

Kuhn (1962) similarly stresses the importance of social context as a factor in determining the sort of knowledge that is produced by scientists. He argues that scientists cannot isolate their thinking from the ideological frameworks in which they work and they are

therefore never completely objective. On this basis, he argues that science is based on subjective interpretations that reflect the paradigms held by society at the historical moment of their generation.

2.7 Chapter Conclusion

At first sight, the history of the relationship between science and religion can be summed up as initially harmonious, followed by a period of conflict arising because of the publication of Darwin's theory of evolution, and now, as far as the religious scientists are concerned, there is a striving for reconciliation.

On closer inspection, it is clear that the situation is more complicated than this. The natures of science and religion have changed during this history and the versions that are perceived to be harmonious at one time are different to those that are said to be in opposition at another.

Changes to science and religion have been made because of new findings, and also in an attempt to reconcile the two fields with each other. Thus today, there are religious scientists who argue that science and religion are harmonious, but who visualise God in ways that are far from traditional.

The nature of divine action is widely considered to be the central question in current discussions. The debate can be summarised by saying that there is disagreement about what "real religion" asserts and what "real science" opposes.

Chapter 3 reviews previous studies of students' beliefs on these issues.

CHAPTER 3
STUDENTS' BELIEFS

3.1 Introduction

The first section of this chapter reviews selected publications that discuss Piaget's theory of cognitive development. Sections 3.3 and 3.4 describe research that applied psychological theory to problems of religious development. Section 3.5 presents findings about students' views about the relationship between science and religion.

3.2 Studies Relating to Piaget's Theory

3.2.1 The Major Characteristics of Stage Theories

About fifty years ago, Piaget and Inhelder (1958) presented a new model to explain the development of children's thinking. This model was fundamentally different to the dominant views about children's thinking at the time because it described mental growth as undergoing major qualitative changes. According to eighteenth-century empiricists, a child's way of thinking is essentially the same as an adult's, the only difference being that the child has made fewer associations (Gleitman, 1986).

Brainerd (1978) and Flavell (1971) list a number of characteristics that distinguish Piagetian stage theories from other types of descriptions of children's development. These characteristics are:

- Children's reasoning in earlier stages differs qualitatively from their reasoning in later ones. The change in the child's thinking from one stage to the next is not simply a matter of knowing more information but reflects the emergence of a different way of processing information;

- Stage changes are concurrent with simultaneous and similar changes taking place across many domains at once;
- Having spent a period of time at a given stage, children move abruptly to the next stage;
- The stages are ordered and all children pass through each stage without skipping or regressing;
- At a given stage, a child is unable to learn to think in ways associated with the next higher stage until they are near that stage or in it.

A number of key developmental theorists, including Flavell (1993) Levin (1977) and Light (1986) and have advanced Piagetian theory and tested its claims. The kinds of questions they have asked are, does cognitive development proceed in stages or continuously; is development domain specific and how do practice, experience and expertise affect development?

In Piaget's original scheme, the transition from one stage to the next takes place abruptly. In contrast, most current theorists believe that development is more of a gradual process (Flavell, 1993). This amendment to the original theory is arguably the most significant.

Post-Piagetian researchers have also tested the ages at which children are seen to have acquired the skills associated with each of the stages. These studies have concluded that Piaget frequently underestimated the abilities of very young children. Mental representation, metacognition, and empathy are cognitive skills that children acquire much earlier than Piaget believed (Baillargeon, 1987; Levin, 1977).

Other studies have looked at the rate at which children progress through the stages in Piaget's model. Loughran (1967) replicated Piaget's (1932) studies of moral reasoning but with adolescent students. He found that the age at which students arrived at Piaget's level of mature autonomous judgement was between 12 and 17 years, not between 11 and 12 as Piaget had indicated.

Light (1986) and Donaldson (1978) investigated the impact of the experimental design on children's apparent mental capabilities. They modified the procedures described in Piaget's experiments in slight ways that should not have affected the results if Piaget's claims were correct as originally presented. They found that in some cases, there was a shift in children's apparent stages of cognitive development when these changes were made.

Another area of debate is whether a child's rate of development is the same across several domains or whether it varies from task to task. According to Piaget's original scheme, an eight-year-old who has attained the stage of concrete operations should be able do all concrete-operations-level tasks such as conservation and class inclusion, but should fail all formal-operations-level tasks such as the projection of shadows and probability. This claim has now been refuted by studies that have shown that the rate of cognitive development varies from task to task (Siegler and Richards, 1982).

3.2.2 Methodologies Used to Develop Stage Theories

The two main types of studies employed by researchers in the field of cognitive development are cross-sectional and longitudinal. Cross-sectional studies are conducted at one point in time and compare individuals at different age levels while longitudinal studies look at the same individuals at different points in time. Cross-sectional studies enable data to be collected relatively quickly; longitudinal studies generally require longer research times (Flavell, 1996). Cross sectional studies run the risk of adventitious cohort effects, however. It might be the case, for example that the individuals within a particular age group experienced significant differences in their education compared with the individuals in another age group due to a national change in instructional methods. A change of this kind could mean that development appeared slower (or faster) than it would if the same cohort of students had been observed throughout. For this reason, most researchers in the field of cognitive development, including Piaget and Kohlberg, have employed cross-sectional designs to establish the initial concepts of their developmental

models in order to obtain data quickly, and then have employed longitudinal studies to test the validity of the sequences.

3.2.3 The Stages of Cognitive Development Within Piaget's Scheme

Despite the challenges and variations that have been made in recent times to Piaget's theory, his fundamental claim that individuals advance through a series of stages of cognitive development during their lives remains and is a dominant view within modern cognitive psychology. It is valuable to summarise Piaget's original description of these stages in the context of this project because they were used by Fowler (1981, 1991) and Goldman (1964, 1965) when they constructed their theories about the stages of religious cognitive development.

The Piagetian stages are:

- The sensorimotor period (Birth to roughly 2 years old): Infants become increasingly interested in outcomes occurring beyond the limits of their own bodies;
- The preoperational period (Roughly 2 years to 6 or 7 years): children develop an understanding of object permanence;
- The concrete operational period (Roughly 7 – 12 years): The central development in this period is the acquisition of the ability to manipulate internal representations of objects. A good example is the ability of a child at this stage to know that the amount of water is conserved if a quantity of water in a tall narrow glass is decanted into a wider glass.
- The formal operational period (Roughly 12 years and beyond): A significant development is the recognition that the child's reality is only one of several possible realities. This leads some children to reflect on the nature of existence, truth, justice, and morality.

3.3 Goldman: A Theory of Religious Cognitive Development

Almost 40 years ago, and following Piaget's lead, Goldman studied the religious thinking of young students and adolescents. Goldman was concerned that students were studying biblical texts set by the British curriculum that contained meanings that were too advanced for their cognitive abilities. Goldman's hypothesis was based on Piaget's proposal that all students follow a common path of intellectual development. For example, until the age of seven, claimed Piaget, children are incapable of thinking about abstract concepts (Piaget, 1952).

Goldman hypothesised that children's religious thinking would also progress through a series of developmental stages, saying, "It is clear that because the forms of thought used by children are childish and immature, children's religious ideas and their concepts will also be childish" (Goldman, 1964, p. 67).

To test his hypothesis, Goldman selected three biblical narratives - The Red Sea Crossing, Moses and the Burning Bush and the Temptations of Christ - and constructed questions about them. His intention was to evaluate the children's abilities to understand the texts according to Piagetian testing techniques (Goldman, 1964).

In Goldman's view, a student who gave an allegorical interpretation of a narrative was at a more advanced stage of cognitive development than a student who gave a literal interpretation.

Goldman charted the developments that took place in students' religious thinking alongside Piaget's stages of intellectual development. He concluded that students advanced more slowly in their religious thinking compared to their advancement in other areas of thinking. In particular, Goldman reported that students generally only developed the ability to draw allegorical meanings from Biblical narratives when they reached adolescence – at about 13.5 years in age. In comparison, according to Piaget's model of intellectual development, the ability to think about abstract concepts is usually developed at an approximate age of seven. Several neo-Piagetian studies have since concluded that development takes place at different rates in different domains such as physical, moral

and cognitive (Langford, 1978). Additionally, since Piaget's original scheme was published, it has been suggested that Piaget "tended to exaggerate the extent to which disparate abilities emerge together as a 'stage'" (Langford, 1987, p. 133).

Goldman suggested that the students' delayed development in religious thinking was probably because they were not given the opportunity to develop such skills in religious studies lessons. Goldman's advice, based on his studies, was that students should be taught thinking skills as well as content, and that biblical texts should only be studied once students were sufficiently advanced to understand their deeper stages of meaning. Encounters with difficult texts before that stage "only creates confusion and difficulties where they need not exist" argued Goldman (1965, p. 33).

3.3.1 The Dualistic System

One of Goldman's most interesting discoveries was that many very young students conceive of the natural world in terms of dualistic systems. Usually when researchers talk about "dualism" they are referring to a trait among young people to see knowledge as "black and white", or assertions as dualistically "true or false". This is a slightly different use of the term. The point about this kind of dualism is that two parallel sources of information are accessed independently, and comparisons are not made between them:

> There is one world called 'religious' and the other called 'scientific'. The first has to do with holy things ... In this kind of world, God was present, moving about the physical world organising thunderstorms, interfering with battles and generally behaving unpredictably. The second is the modern world they know of, with cars, central heating and television, in which thunderstorms can be explained by natural laws, and about which they try to think logically.
>
> (Goldman, 1965, p. 53)

Piaget (1930) described a similar process, saying that children tend to look at the world through dual methods that the child does not see as contradictory, saying, "One is

theological and allows for supernatural intervention; the other is artificialist-scientific and gradually gives way to natural explanations" (p. 27).

Although most students begin to bring their religious and scientific ideas together by the time they start secondary school, some students appear to carry this dual frame of reference through to adolescence (Goldman, 1965).

Many years later, Roth and Alexander (1997) reported that they also found school students who held this dualistic frame and who switched from one mindset to another as they moved between their science and religious studies classes. At about the same time, Fysh and Lucas (1998a) were also investigating this phenomenon but reported that they did not find evidence of dualistic mindsets in the Australian students they interviewed. Their study is referred to again below.

3.3.2 Why Some Adolescents Reject Religion

According to Goldman (1965), because young children interpret the Bible literally, to their still concrete way of thinking, the Bible is about "holy people in a holy land, clad in special holy clothes" (p. 37).

There is a danger, reports Goldman, that if students retain these literal views into adolescence, when they do finally examine them, they will reject most if not all of what they learnt in their religious education as untenably juvenile (Goldman, 1964). O'Dea (1966) also warns of this danger when he says that, "a youth who accepts the truths of his religious faith without question is often unprepared when doubts arise" (p. 96).

Many years previously, Hall (1904) and Erikson (1959) both warned that as they examine their beliefs, students typically become disillusioned and reject the beliefs they have carried through childhood.

Glanz (1966) and Ausubel (1977) found evidence to confirm the suggestion that a rejection of religion tends to occur at an age of between 14 and 16 when students begin to examine religious beliefs that include literal interpretations of Biblical texts that they have

previously assumed to be true. According to Duke and Whitton (1977) many students turn away from religion at about the same time that they stop believing in magic, a point at which the "'fairy story version' ends" and before anything "more 'grown up' might take its place" (p. 19).

Rossiter (1996) concurs with this view, and recommends that to encourage students to retain their faith, students should be informed about the possibility of taking a non-literal view of the Genesis accounts Rossiter explains that if students are not aware of this option then they may reject the entire religious tradition while unaware that they could have taken this less radical course. Dagher and BouJaoude (1997) observe that this path may not solve the dilemma for all students, since those who were brought up to believe that the Literalist perspective is the true one will almost certainly find the idea of taking an allegorical view unacceptable.

3.4 Stages of Development in Faith

Fowler (1981, 1991), following Piaget (1952) and Kohlberg (1964), produced a stage theory that describes how faith develops from childhood to adulthood. In Fowler's model, faith develops through six universal stages. Transition from one stage to the next, stated Fowler, is brought about by an emotional or conceptual crisis. Table 1 presents an overview of Fowler's stages of Faith Development.

Table 1

Fowler's Stages of Faith Development (Fowler, 1981)

Stage	**Description**
Stage 1 (age 3-7)	Intuitive-projective: egocentric. Beginning of thought and language. Own perspective. Events are isolated and disconnected.
Stage 2 (age 7-11)	Mythic-Literal: Concrete operational; symbols and moral rules are interpreted literally, acceptance of authority. Strong sense of justice.
Stage 3 (age 12 up)	Synthetic-Conventional: conforms to majority views and stereotypes; Learns to take another person's point of view. This is a stage at which many adults remain.
Stage 4 (late adolescence up)	Inductive-Reflective: Those who reach this stage struggle with questions, scrutinising previously unquestioned beliefs leading to a new outlook with own values.
Stage 5 (midlife if at all)	Conjunctive: Paradoxes are accepted, as are the validity of other peoples' belief systems. There is a new sense of justice that recognises issues beyond those that are relevant to the individual's own culture and tradition.
Stage 6 (few people reach this stage)	Universalising: contributes to the world.

Since the current study looks at the views of university students, two stages in Fowler's model are particularly relevant to this current research. On reaching adolescence, most students acquire the abilities to use logic, to evaluate ideas and to think about abstract ideas. Piaget described this stage as the stage of formal operations. Fowler suggested that adolescents rarely apply these cognitive capabilities to religious thinking, however. Instead, they conform to the beliefs of their peers and family, forming beliefs that tend to be mostly conventional. At this stage, called stage 3 in Fowler's model, the student holds a "more or less consistent clustering of values and beliefs, but he or she has not objectified it for examination and in a sense is unaware of having it" (Fowler, 1981, p. 173). Thus as they begin their university courses, students are likely to have strong opinions about the meaning of life but may not yet be able to rationalise why they hold

these beliefs. Fowler describes this stage as stage 3 and says that many individuals do not advance beyond this stage.

Some students, however, do examine their beliefs, perhaps as a result of their exposure to the contrary beliefs of others. As students reflect on their faith, Fowler predicts that many will progress to stage 4, at which point the student demythologises his or her faith and "typically translates symbols into conceptual meanings" (Fowler, 1981, p. 182). Students at this stage may criticise the high degree of ritual in organised religion, as they look for the meaning behind each symbol and custom.

Individuals advance to stage 5 in Fowler's model during midlife, if at all, and so this stage is less likely to be represented.

Fowler subsequently softened the discrete nature of the stages, saying that the boundaries are not clear-cut, and that individuals may spend a long time in transition from one stage to the next (Fowler, 1991). The implication of this is that individual tertiary students might display the kinds of thinking associated with adjacent stages rather than with just one stage.

3.4.1 Teaching Alternative Views of the Relationship

The suggestion was given in the previous section that to help students resolve the apparent contradictions between science and religion it would surely be of benefit for them to study the various views of the relationship given in the literature. To be effective, students would need to be reasoning at the cognitive stage of formal operations – the stage at which they can reason logically and systematically. This stage is generally reached at age 12, although, again, in religious thinking it may arise at a later age – perhaps as late as age 16 (Goldman, 1965). Students who attempt to study these matters prior to this stage may not be sufficiently intellectually advanced to grapple with the issues involved.

This hypothesis was proposed and investigated by Australian researchers, Fysh and Lucas (1998a) who surveyed and interviewed 44 students attending a Lutheran secondary

school. They found that students in Year 10 (age 14) were indeed unable to understand the issues involved in apparent contradictions. They also reported that students in Years 11 and 12 (age 15 and 16 years old) were more easily engaged in the discussions. It is also worth noting that this study found that the senior students interviewed showed "unexpected complexity and apparent internal inconsistency" within their individual personal views (Fysh & Lucas, 1998a, p. 63).

3.5 Students' Views of the Relationship Between Science and Religion

3.5.1 Schneller

The aims of research by Schneller (1982) are similar to the aims of this project. Indeed his work could be described as a forerunner of this research. Schneller's project differs from many other projects that look at the views of students, not least because he highlights a distinction between the terms contradiction and conflict. Schneller explains that if two statements are contradictory, it means that accepting one precludes the logical possibility of accepting the other. Conflict occurs when "one wants to retain and accept both of them" (Schneller, 1982, p. 256). This distinction is an important one because Schneller is interested to know not only whether students see contradictions between science and religion, but also whether they are troubled by them. Schneller quotes previous research by Jersild (1968) which reports that students confronted with apparent contradictions prefer not to address them. Schneller constructed four written dilemmas in which traditional Jewish beliefs appear to be contradicted by empirical science. The topics were:

- The method of formation of the world: the Bible says God created the Earth; scientists explain that it evolved naturally.

- The age of the world: Jewish religion traditionally says the Earth is less than 6000 years old, but current scientific texts state that the Earth is hundreds of millions of years old.

- The uniqueness of man: were humans created separately or did they evolve?

- The forces of nature: whether they are directed by God or follow unchanging laws.

In his first study, Schneller surveyed 203 school students in grades 11 and 12. He offered five basic approaches to resolving the contradictions. These are shown in Table 2.

Table 2

The Approaches Given in Schneller's First Study

Approach	**Explanation**
Affective	The view that nature demonstrates the greatness of God;
Congruence	The notion that religious texts in Judaism should not be read literally;
Dualistic	Proposal that there is a separation of goals, language methods etc;
Criticism of science truth claim	The view that science is not the absolute truth and that faith in science confronts faith in Judaism;
Critical analysis of specific scientific theory	A focus on what is said to be the core of the problem and the claim that it could be in error. Eg evolution is not a fact.

Schneller (1982) found that the majority of students selected the affective view, confirming the result that Jersild had found in 1968. Schneller explains this by saying that students chose a view that allowed them to avoid confronting the contradictions (Schneller, 1982). In a second study Schneller surveyed tertiary students (aged 20-24). In this study, the affective solution was omitted in order to narrow the students' selection to one of the cognitive approaches. Schneller reports that the most frequently selected view by the older students was the independence view (which Schneller calls dualistic). It is

interesting that he does not report that any students spontaneously requested the affective solution when it was not offered. The least popular view was a view that calls the scientific statement into question. Schneller sees the lack of support for this view as an indication that students are not aware of the limitations of science. This, he claims, is a matter that teachers should seek to remedy. A criticism of both studies would surely be that students were constrained to choose from a set of responses which may not have included the range of responses they supported between them. Furthermore, because Schneller presented solutions to the dilemmas, his methodology does not obtain information about how students arrive at their final decisions.

3.5.2 Stohlberg and Fulljames

Stolberg and Fulljames (2003) investigated the proposal that Barbour's typology of 1966 could be used to categorise tertiary level students' views about the relationship between science and religion. Stolberg and Fulljames conducted a questionnaire with 72 theology students who had just completed modules looking at the interaction between science and religion. The ages of the students varied from 17 years to over 65 years. In addition, 13 of these students were selected on a convenience basis to take part in semi-structured interviews.

Stohlberg and Fulljames (2003) assert that dialogue is the preferred view in the minds of those who design and run science-religion courses. They found that this view was also widely supported by students but was not the only viewpoint that the students adopted. There was some support for the view of conflict by the students in the sample, but very little for independence and very little for integration.

In a finding that is also a conclusion of an early phase of my study, Stolberg and Fulljames (2003) state that Barbour's typology is of limited value as a way to categorise students' views. On most occasions it was found that students' responses did not fit neatly into Barbour's categories. For example, in Barbour's typology, the categories of conflict and dialogue are presented as alternatives. Francis, Gibson and Fulljames (1990) report that about half the respondents said they supported a combination of these two views. As

another example, students did not discriminate between the categories of dialogue and integration, indicating that an ideal typology for students' views would arguably not use these two descriptions to define separate categories. In a previous study, Francis, Gibson and Fulljames (1990) concluded that theology students frequently do not identify with the mindset of one single view, but rather they draw on a richer set of concepts that covers a wider range of issues than just the relationship between science and religion to form their own frameworks for dealing with these kinds of questions. Another significant conclusion of the study was that all the theology students in the sample felt that it was possible to value science while not feeling obliged to regard science as the route to absolute truth.

3.5.3 Tension Regarding Perceived Contradictions

Several surveys and interviews have been carried out to discover whether students are aware of contradictions and how they feel about them. Canadian researchers Roth and Alexander produced two case studies designed to illustrate how adolescents may react emotionally to the discovery that science and religion appear to contradict. The case studies were based on interviews with two boys who met with the researchers several times during the course of several years. On discovery of the apparent contradictions in his views, one boy, Todd moved to a view in which religious explanations were seen as analogies. The other, Brent, desired to maintain the view that both science and religion offer absolute literal truth (Roth & Alexander, 1997).

As a result, reported Roth, Todd did not experience emotional conflict when he reflected on his religious and scientific beliefs. For example, on the topic of the Creation, Roth quotes Todd as saying:

> My non-literal understanding of the biblical Creation story interfaces with my conception of an immaterial God that revealed itself to Moses as an entity without image.
>
> (Roth & Alexander, 1997, p. 139).

By comparison, Roth reports that Brent struggled to maintain his religious faith. For example, Brent is quoted as saying:

> from my perspective there are no similarities between science and religion at all... they do not connect at all... in science I feel like I am drawn away from religion and that really worries me a lot.
>
> (Roth & Alexander, 1997, p. 140).

Rossiter (1996), Esbenshade (1993) and Fleener (1996) agree that some students can become concerned about the apparent contradictions. For example, Esbenshade reports that some students say that the fact that science appears to challenge their religious faith is a disincentive from pursuing careers in science.

In contrast, Fysh and Lucas (1998a) who interviewed secondary school students in Australia report that while many adolescents acknowledge that contradictions exist, they do not consider them to be of major concern to them personally. Only nine of the 44 students interviewed in the study said there were more than "rare clashes" between science and religious content in the classroom. Fysh suggests that researchers who report a greater degree of conflict might perhaps have reached a different conclusion if they had asked students whether they were personally emotionally affected by the contradictions. Another possibility would be that Australian students are by nature less emotionally engaged by these kinds of questions.

3.5.4 Reich

Reich (1989) is interested, as I am, in the changes that occur in students' thinking about science and religion as they advance cognitively. The model he proposes builds on the widely held belief that advanced thinkers hold views that are more organised and conscious than the views held by novices (Basseches, 1984; Langford, 1995; Perry, 1970, Reich 1989). This movement towards consistent and detailed thinking is also the basis of the conceptual scheme of cognitive development that I present in this thesis.

In his scheme, Reich identifies one particular approach, the view of complementarity, as the most advanced way of thinking about these issues. He explains that complementarity is an approach that requires individuals to integrate their scientific and religious understandings, a task which he says requires thinking in unconventional ways which go beyond Piagetian formal operations. In an argument which is also put forward by Duce (1998), Reich explains that there are no general rules to be followed when deciding whether to reinterpret science or religion when attempting to form a response based on the two fields. Instead, scientific and religious descriptions must be studied and compared case by case. Reich (1990) proposes that the cognitive difficulty of this approach would explain why many Christians struggle with the idea of complementarity, even though it is now promoted in numerous and widely available publications by religious scientists.

Reich (1989, 1990) constructed a scheme of religious development in which the approach of complementarity is the most advanced way of thinking about science-religion dilemmas. To test his scheme, Reich interviewed adolescents on the subjects of evolution and creation, and found that the students in the sample had attained this arguably highest level of development and were linking scientific and religious explanations.

Sharp (1991) criticises Reich's scheme, saying that Reich does not give a sufficiently compelling reason to persuade him that the complementary view is the most cognitively mature way of thinking about the relationship. Sharp argues that Reich is personally attracted to the Complementary model because it allows individuals to say that there are no real contradictions between science and religion. Sharpe's view is that a greater indication of maturity might be the ability to decide whether a conflict rightfully can be redefined in terms of a complementary relationship or not.

3.5.5 Resistance to Learning Science

Several researchers have sought to find out whether students who hold religious beliefs find it more difficult than their non-religious peers to gain scientific knowledge about selected topics. Their findings are mixed. Dagher and BouJaoude reported that religious beliefs interfered with students' understanding of the theory of evolution because they

influenced how students evaluated the evidence (Dagher & BouJaoude, 1997). Goldman also predicted that students would resist learning scientific accounts that contradict their existing knowledge (Goldman, 1964, p. 31). Smith advises teachers to tackle concerns early to remove such resistance (Smith, 1994).

Fysh and Lucas (1998a) were also interested to discover whether Christian students would reject science when it contradicted their religious beliefs. As stated above, Fysh and Lucas came to the surprising conclusion that the students in their study were not disturbed by the existence of contradictions. Their conclusion was consequently that contrary beliefs would not interfere with students' abilities in science.

In further support of this conclusion, Lawson and Worsnop (1992) discovered that learning more about evolution did not cause a significant change in students' religious beliefs.

Subsequently, it was shown that holding incompatible religious views could have a positive affect on a students' interest in science (Brickhouse, Dagher, Letts & Shipman, 2000). The research found that students with prior religious views were more likely to engage with the concepts presented to them in an astronomy course than students who did not have religious views. The suggestion was that this is because the Christian students had more reason to want to know about astronomy in order to find out how it interacted with their religious beliefs (Brickhouse et al, 2000).

3.6 Students' Views about the Nature of Science

The nature of science has been discussed by scientists and theologians. Some of their opinions are set out in the previous sections of this literature review.

More recently educational researchers have taken an interest in students' views of the nature of science. Driver is one of many researchers who have interviewed students to discover their views about the nature of science. Her research reveals that most British secondary school students hold the impression that science provides a complete and

infallible description of the world (Driver, Guesne & Tiberghien, 1985; Driver, Squires, Rushworth, & Wood-Robinson, 1994; Driver, Lead, Millar, & Scott, 1996).

Australian research indicates that school students in this country hold a similar opinion (Champagne, Gunstone & Klopfer, 1985; Gunstone & White, 1981; Gunstone, 1990; Tasker, 1981). Their findings are in line with the claim by King and Kitchener (1994) that most school and many university students perceive humanly acquired knowledge to be true and absolute.

Educators around the world have sought ways to encourage students to see science in a more realistic and less alienating way. In Victoria, for example, the Curriculum and Standards Framework states that students should be taught to "recognise the limitations of science" and to become aware that "while theories in science are never finally agreed upon, they are powerful ways of explaining the world" (State of Victoria, 2000, p. 5). In line with this message, many teacher-training courses now encourage future science teachers to probe their own views about the nature of science and to consider how teachers can influence their students' views about the nature of science (Sperring, 2000).

Despite such measures, which began to emerge in the 1980s, researchers continue to find that many students, and even their teachers, understand science to be a static collection of facts (Dawson and Taylor, 1997). It seems that teaching students see to science as a way to find things out, rather than as a closed body of knowledge is proving particularly challenging (Loughan, Berry, Mulhall &, Gunstone, 2003).

PART 3: METHOD AND PROCEDURES FOR THE FIRST EMPIRICAL STUDY

CHAPTER 4

THE NEED FOR A STUDY OF THIS KIND

4.1 Introduction

In this chapter, it is argued that the existing typologies of views of the relationship between science and religion could not be used to categorise the views of laypeople.

4.2 Why Existing Typologies were Unsuitable

One of the aims of this research is to describe students' approaches to science-religion dilemmas. In the literature review, many views of the relationship between science and religion were described are these are summarised in Table 3. The list includes the views that are said to be held by students in addition to those held by experts in this field.

Table 3

Collated Views of the Relationship Drawn from the Literature

Non-reflective views	
Dualism	The individual is unaware of contradictions because he/she has not compared the information we receive from science and religion.
Reflective Views	
Conflict via Biblical literalism	The Bible is held to be literally true, even where science repudiates a literal religious assertion.
Conflict via Scientism or Scientific Materialism	It is held that science repudiates the possibility of any kind of supernatural intervention.
Complementary	The view that science and religion do not overlap. Taken together, they provide a more complete picture of reality than either can alone. This view is also called Two books and Independent
God of the gaps:	The view that God created the universe and His actions also fill the gaps in natural explanations.
Deism and determinacy	The view that God created the universe and the laws of nature. The universe now proceeds without further divine intervention.
Scientific theology:	Supporters of this view argue that the apparent design of the universe demonstrates God's existence.
Affective:	Supporters build on the idea that God's existence has been proved using the "argument from design", and insist there can be no contradictions between science (nature) and religion.
Dialogue:	The view that those who work in science and in religion should exchange of ideas looking for commonalities
Integration	A general statement of commitment to the idea that the scientific and religious accounts can be combined.
Assimilation	Supporters of this view reformulate religious assertions to remove contradictions between the literal Bible and mainstream science.
Consonance	A view that requires science and religion to be reformulated in order to achieve harmony while respecting essential religious beliefs.

4.2.1 The Value of this List in my Study

The aim of the current study is to describe the approaches that tertiary-level students and academic experts take when they encounter science-religion dilemmas. The list in Table 3 seems like a reasonable starting point for the study. On closer inspection, however, it becomes apparent that this list is not an adequate typology to describe the approaches taken by students, nor does it facilitate the task of comparing students' approaches with the approaches taken by academic experts. This unsuitability stems from two main issues.

4.2.1.1 The Range of Responses Obtained in Pilot Interviews

Shortly into this study it became apparent that the list of views in Table 3 does not contain enough categories to encompass the range of non-reflective approaches that students take. Indeed, this list has only one non-reflective category which represents the approach taken by students who are unaware that contradictions between science and religion exist. A pilot study consisting of interviews with 20 undergraduate students revealed that some students were aware of the apparent contradictions, but chose not to reflect on them. This strategy was also not included in the typologies of expert approaches.

4.2.1.2 Overlapping Categories

The second issue is that the arrangement of the views in Table 3 is far from systematic. The table presents an assembly of views drawn from many sources. As a result, the categories are not distinct. Furthermore, some of the views in Table 3 do not reveal how the holder of the view would respond to apparent contradictions. The view of Scientific Theology is a view that focuses on a way in which science appears to support religion and leaves open the question of how to respond to apparent contradictions between the fields.

4.2.2 Comparing Students' and Academic Experts' Approaches

The typology described by Barbour (1988) was also considered as a possible starting point for a typology that would include students' views. The major obstacle in this case is that the views described in Barbour's typology are defined by referring to philosophical considerations of the general relationship between science and religion. It became increasingly apparent when the transcripts of the interviews with students were analysed that students were not conversant with the questions and terminology that Barbour and other academics use, and that it would be unwise to interpret the students' comments using the definitions given in the formal academic literature.

The term "independence" provides an example. When Barbour describes the view of Independence, he is describing a view in which science and religion are considered separate realms with the result that they cannot produce contradictions (Barbour, 1988). Some students, however, described science and religion as "independent", and then indicated they believed there are contradictions between the realms:

> "One is spiritual the other is factual. They're not related ... There are lots of contradictions" (Student MU-P-60);
>
> "They're separate - as in independent. By definition they are... Yes, there are contradictions" (Student MU-P-71).

Other researchers have reported a similar finding (see for example Esbenshade, 1993; Fleener, 1996; Fysh & Lucas, 1998a, 1998b; Roth and Alexander, 1997; Scharmann, 1993; Schneller, 1982). In this thesis, it will be argued that the lack of accuracy and detail within students' comments on some issues arises because the high-level philosophical questions that are often referred to when discussing science-religion dilemmas in the literature are not always clear in students' minds and may not have been addressed.

The task that followed was to decide what kind of typology would be suitable to describe the approaches taken by laypeople and academics.

Another option that was considered was to define students' approaches in terms of how they responded to specific apparent contradictions, such as "God created life versus life

began naturally". This option was rejected because as it turned out, many students have strategies that allow them to avoid reflecting on the detail of the dilemma. When they take these strategies, students do not identify contradictions but instead, make a decision about what to believe by looking at the dilemma as a whole. If the typology only described the range of students' responses to apparent contradictions, then the details of these dilemma-level strategies would not be included.

The aim that was finally adopted for this study was to describe the way that students and academic experts approach science-religion dilemmas. A dilemma is at topic on which both science and religion have something to say and in which there are apparent contradictions. In pilot interviews it was noted that at this less conceptual level of discussion, most undergraduate students gave what seemed to be reasoned comments in contrast to their unclear and occasionally ambiguous descriptions of the overall relationship between science and religion. With the approaches defined in this way, it would also be possible to include strategies that operated at the dilemma-level. Chapters 5-12 describe the interview schedule and the methods of analysis that were constructed for the study.

CHAPTER 5

INTERVIEW DESIGN AND DATA COLLECTION

5.1 Introduction

The primary instrument for data collection was a semi-structured interview which used direct personal questions and questions about science-religion dilemmas. In the personal section of the interview, students were asked about the relationship between science and religion, whether they were aware of apparent contradictions between the fields and how their views had changed since childhood. There were two dilemma sections in the interview. In the "Spoken Dilemmas" section, students were asked to suggest topics that are covered by both science and religion, and to identify apparent contradictions within these topics. In the "Written Dilemmas" section, students read three written dilemmas and were asked to identify apparent contradictions between the paragraphs.

In the first study, 20 undergraduate students were interviewed. This chapter describes the rationale for the methodology, the recruitment of participants and the design of the semi-structured interview schedule.

5.2 Rationale for a Qualitative Methodology

Qualitative research is a valuable way to become more experienced with a phenomenon of interest. Hayes explains that:

> Qualitative methodology has tended to be associated with a concern on the part of the researcher with meanings, context, and a holistic approach to the material. It has generally been set in opposition to quantitative methodology
>
> (Hayes, 1997: pp. 3-4)

While the focus of a quantitative study might be to test the validity of a hypothesis, qualitative studies tend to focus on generating and exploring hypotheses (Hammersley 1992; Silverman, 2001).

There are several methods to gather data for a qualitative study, such as focus groups and field studies, and interviews. In depth-interviews are widely used to develop a deep understanding of how people think about a topic and are particularly suited to the task of discovering people's opinions on sensitive issues, such as religion, human sexuality, the death penalty and gun control (Kidder & Fine, 1997). In this way, the research is carried out with a group of participants rather than "on" a group of volunteers (Burman, 1997).

A semi-structured interview schedule was constructed. This format ensures that participants address a set of common questions but format also allows the interviewer to follow new leads as they arise (Bernard, 1988). The format was suited to this research because not enough was known about students' ideas to conduct a survey, because the aim was to compare students' responses to similar questions, and because it was necessary to clarify students answers when they were ambiguous. The semi-structured interview is a method that "allows depth to be achieved by providing the opportunity on the part of the interviewer to probe and expand the interviewee's responses" (Hitchcock & Hughes, 1989, p. 83).

5.3 Recruitment of Participants

Before commencing the interview phase of the project, ethical approval for the study was obtained from the Ethics Committee at La Trobe University where I was then a PhD student. In addition, permission to recruit and interview students for the study was obtained from the Monash University Office.

Monash University was selected as a suitable campus from which to recruit students for the study for two main reasons. Firstly, the campus is frequented by male and female undergraduates studying arts and science subjects, providing the opportunity to ensure a

balance of these groups in the study; secondly the campus is a relatively short journey by car from my home.

During the pilot phase of the study, 20 Monash university undergraduate students were recruited from and interviewed at several locations around the campus. These interviews provided the opportunity to detect ambiguous questions and to ensure that the length of the interview was reasonable. During these sessions, the refectory emerged as a particularly good venue from which to recruit participants on the basis that the students in this area most frequently agreed to spend the time required to take part in an interview.

To recruit 20 participants for the first sample, students were approached in a semi-random fashion in the refectory area. Participants were selected in a way to ensure that the final sample contained ten male and ten female interviewees; all the students were fluent in English, and all the participants were undergraduate students at the university.

Students were approached with the words, "Hello, can I bother you? I'm looking for someone to help me with my research. Can I interview you please?" Students were asked if they would agree to a thirty-minute interview, which would be recorded on audiotape and subsequently transcribed.

The main factor that seemed to determine whether students agreed to an interview was the time of day, with the most acceptances taking place at lunchtime and teatime on weekdays.

Students were only told the subject of the interview after they had agreed that they had the time to take part. This step was an attempt to reduce a bias in the sample towards those who were interested in the topic. Each student was identified on the tape and transcript by MU and an individual number. (MU stands for Monash Undergraduate.) Each student who was approached was given a number whether or not he/she agreed to be interviewed. The topic was introduced as, "I'm looking at science and religion and what people think about them." Students were then invited to withdraw from the interview if they did not want to proceed. No students withdrew at this stage.

Within the refractory building there are several cafés. One of these had a quiet location in a seating area some distance from the food service area. Recruits were asked to move to this area for the interview. This provided a friendly and comfortable location with relatively little background noise.

5.4 Questionnaire

Before taking part in the interview, students completed a brief questionnaire to ascertain personal details such as age and religiosity. The ages of the students ranged from 18 to 29, with an average age of 20.7 years. Six students were studying science subjects. Ten students described themselves as "Religious" (which was defined for the students as believing in God more than not), seven as "Agnostic" and three as "Atheist". Additional details are given in Appendix B.

5.5 The Interview: Overview

Stewart and Shamdasani (1990) advise that when devising the questions for an interview schedule, the starting point should be the research questions and the aims of the study. The aims of this part of the research was to discover the extent to which students reflected on the apparent contradictions as they formed their beliefs and to understand why students arrived at the view that contradictions existed. An interview schedule was constructed to find out:

- Are students aware of apparent contradictions between science and religion?
- Do students reflect on these apparent contradictions as they formed their beliefs?
- Are students' views of science and religion influential in guiding them to particular views?
- Have students changed their views during their lives, and if so how?

The design of the interview was constructed so that the questions were general at the beginning of the interview, and more specific as the interview progressed, a structure recommended by Stewart and Shamdasani (1990). This design also ensured that the more challenging questions which related to the written dilemmas came later in the interview when students were more comfortable. The benefit to the project of establishing a rapport between interviewer and interviewee is well established (see for example Brenner, Brown & Canter, 1985; Fowler, 1995; Seidman, 1991).

To encourage students to talk freely, students were informed before questioning began that, "there are no right or wrong answers, I'm interested in your ideas."

5.5.1 General Relationship between Science and Religion

In the first section, students were asked about the nature of science, the nature of religion and the general relationship between science and religion. Students were asked to describe the relationship in their own words, rather than to respond immediately to the suggestion that the relationship is one of conflict. Later students were asked to comment on the widely held view that science and religion are conflicting.

The six questions in Section 1 of the schedule were:

1.1 So I'm looking at science and religion. What do you think it's important to say about this topic?

1.2 What is science?

1.3 What is religion?

1.4 How would you describe the relationship between them?

1.5 Some people say that science and religion conflict. What do you think about that view?

1.6 What about for you personally? Are there any clashes between science and religion for you personally?

Pilot interviews using a similar interview schedule revealed that most students talk about "conflict" early in the interview, before the interviewer introduces the term. During these pilot interviews, it was noted that the meaning of the term is ambiguous, because some students assume that a conflict is equivalent to a "contradiction" while others believe that there is only a "conflict" if emotional turmoil is involved.

To avoid this potential for ambiguity, after question 1.6 in the main study, students were asked to use the term contradiction to refer to incompatible assertions.

The remainder of section 1 asked students to identify topics that contain apparent contradictions, and to say whether the existence of contradictions caused them tension. This line of questioning revealed that many students were aware of unresolved contradictions within their own views but took strategies to deliberately avoid mental tension.

5.5.2 The Spoken Dilemma Section

A science-religion dilemma is a topic on which science and religion offer information that appears to contradict. In the interview, students encountered dilemmas in two ways. In Section 2 of the interview, students were asked to suggest topics that are common to both science and religion and to identify any contradictions between them. Later in the interview, students were presented with three written dilemmas. A series of standardized dilemma questions probed students' awareness of apparent contradictions and their reasoning about the dilemmas The questions in Section 2 were:

2.0 Can you think of any topics on which both science and religion have something to say?

2.1 What does science tell us about that topic?

2.2 What does religion tell us about that topic?

2.3 Are there any contradictions between those views? (What?)

2.4 TAKING EACH IN TURN: Is it a contradiction between science and religion for you personally? Why/Why not?

2.5 Does this contradiction cause you tension? Why / Why not?

2.6 Have you resolved the contradiction? How?

2.7 Can you tell me about any other contradictions that you think other people would say exist? Have you resolved this contradiction? How?

The questions ensured that students talked about how they reached their conclusions (their approaches to the dilemmas) as well as their beliefs. Asking students to talk about their beliefs may not reveal the depth of their reasoning. Students may have learnt beliefs that apparently resolve science-religion conundrums without being aware of the original problems that led others to construct these solutions. For example, there may be individuals who were taught to believe in a theistic but non-literal account of how human life began. To simply ask these students to describe their beliefs would not reveal whether they had considered alternatives before arriving at their current beliefs.

Question 2.4 in the schedule asked students whether the contradictions were an issue for them personally. The purpose of these questions was to discover whether the student saw the contradictions as real – that is, they are contradictions between assertions that the student regards as authentically scientific and religious, or whether they were perceived to be only apparent or in other words, contradictions that arise when the religious account or scientific account is misinterpreted. As an example, the statements "God created humans" and "evolution produced humans" are said to contradict by some individuals and not others. The contradiction is real in the opinion of someone who takes a literal view of what is written in the Bible, but is only apparent in the view of an Assimilationist who reformulates religious traditional Biblical texts.

Students were asked to identify the contradictions that they perceived as only apparent as well as contradictions that they perceived to be real. The term "apparent contradictions" was thought to be unfamiliar to students and was replaced by the phrase, "contradictions that other people might perceive". The question was intended to discover whether there were individuals who had identified and resolved particular apparent contradictions and to distinguish them from individuals who had not considered the possibility of contradictions.

The section of the interview that presents the written dilemmas to students is discussed in more detail in Chapter 5.5.4.

5.5.3 Students' Past Approaches

In Section 3 of the interview, students were asked to talk about any changes they had made to their views during their lifetime. They were asked to describe the way in which the relationship between science and religion was dealt with (if at all) at school.

5.5.4 The Written Dilemma Section

The written dilemmas section followed the approach taken by Piaget (1932) and Kohlberg (1969). The dilemmas ensured that all the students addressed the same topics which allowed comparisons to be made between their approaches. Each dilemma consisted of two paragraphs, one of religious information and one of scientific information, on a given topic. The dilemmas were introduced with the words: "These are some ideas that other students have given me." Students were told that the views had come from fellow students rather than from authoritative texts to encourage them to challenge the views if they disagreed with them.

Students were asked to identify apparent contradictions between the paragraphs. The questions also asked students to identify contradictions that other people might perceive.

5.5.4.1 The Selection of Topics for the Dilemmas

There are numerous topics on which science and religion both have something to say and on which they could potentially come into conflict. There are ethical dilemmas regarding the use of cloning technology, for example. The conflicts considered in this research are only those that are produced by differences in the content of science and religion.

These conflicts occur when science and religion make statements about the same aspect of the physical universe that some people say are incompatible or contradictory. Frequently discussed topics are how life began, how the universe began and the processes that can cause physical change (miracles).

Based on the literature referred to in previous sections, it is considered that there are four major themes that underlie many if not all of the apparent contradictions between science and Christian based religion:

- There are contradictions between the Bible and science regarding some physical data and historical events. An example would be the age of the Earth.
- The role of divine action in the universe is a central issue. Many questions on closer examination transpire to be related to this issue. Whether God, is personal and active, the efficacy of prayer and the beginning of life are three examples.

Three topics were selected from the literature on the basis that between them, they presented the range of contradictions. Two of the topics are referred to in the science curriculum. The third focuses on whether God interacts with the universe today. The topics are:

- Creation: The beginning of the universe;
- Life: The origins of human life;
- Prayer: The efficacy of prayer and the degree to which God can and does intervene with current events.

The questions that followed each of these dilemma topics were very similar to those already outlined in Chapter 5.5.2. They were:

4.1 First, do you have any general comments about what you've just read?

4.2 Are there any contradictions between these two views given here?

4.3 TAKING EACH IN TURN: Is it a contradiction between science and religion for you personally? Why/Why not?

4.4 Does this contradiction cause you tension? Why / Why not?

4.5 Have you resolved the contradictions? How?

4.6 Can you tell me about any other contradictions that you think other people would say exist? Have you resolved this contradiction? How?

4.7 Have you thought about this issue before?

The questions once again were constructed so that students would raise the contradictions that were relevant to them (real) and then raise those that they perceived would be relevant to others (apparent). A selection of the contradictions that some people might say exist are presented in Table 4. Not everyone would agree that these are real contradictions.

Table 4

Selected Apparent Contradictions in the Written Dilemmas

Written Dilemma	**Apparent Contradictions**	**Nature of Contradictions**
Creation (Big Bang v Genesis)	◦ Biblical Literalism states that the Creation took six days. Science states it took millions of years. ◦ Biblical Literalism states that Creation is a completed act; Science describes Creation as a continuing process.	◦ Contradiction regarding Physical data; Contradiction regarding miraculous action

	◦ Science describes a universe that runs itself. God is redundant; Many religions state that God intervenes with events according to his will. ◦ Some scientists argue that the universe began naturally and spontaneously	◦ Contradiction regarding Physical data ◦ Contradiction regarding theistic action ◦ Contradiction regarding divine creation
Life (Adam and Eve or evolution)	◦ Science states that life arose by blind chance; Religion states it was an act of God. ◦ Biblical Literalism states that human life began with Adam and Eve. Science states it began with single-celled creatures in the oceans. ◦ Evolution is an aggressive and merciless process. Many religions state that God is good and loving – which would seem to rule out evolution as a way that God achieves His will.	◦ Contradiction regarding divine creation and/or theistic action ◦ Contradiction regarding Physical data and contradiction regarding miraculous action ◦ Contradiction regarding discrete theistic action
Miracles and prayer	◦ Many religions indicate that responses by God can be requested through prayer. As such, these religious views claim that God can interact with the world to produce changes physically; some scientists argue that physical change can only be produced in a predictable way by natural causes. ◦ Some religious groups propose that God can act miraculously in response to prayers.	◦ Contradiction regarding theistic action

		◦ Contradiction regarding miraculous action

5.5.4.2 Gathering the Material

The content for the paragraphs was drawn from comments by students in pilot interviews together with the arguments presented in the publications by religious scientists. Several versions of the Bible were also referred to, particularly, the Good News Bible, a translation that was developed with youth readers in mind (1976), the New International Version (NIV) of 1978, and the New Revised Standard Version (NSRV) of 1990.

5.5.4.3 Methodological Issues

One of the purposes of the written dilemmas, in contrast to the questions at the beginning of the interview, was to present some of the ideas that were presented in the literature and in pilot interviews to discover whether students would select any of these commonly described solutions to the dilemmas. The second topic on how human life began, for example, refers to a willingness to take a non-literal interpretation of the Bible which many religious scientists see as essential if the apparent contradictions are to be resolved.

It was a point of interest to discover whether students would identify and discuss these themes once they were introduced given that Vygotsky (1962) says that students are able to appreciate the arguments that belong in a stage above their current level even though they can generate only arguments that characterize their own level.

Given that opinions differ as to whether the apparent contradictions are "real", it was noted that students should be asked whether the contradictions that they identified were present in their own views.

5.5.4.4 The Beginning of the Universe

The scientific paragraph in the first written dilemma described the beginning of the universe in terms of physical processes and then claimed that the account was complete and that there was no need or role for God.

The religious view presented a version of the Biblically literal account of the Creation, and ended by claiming that acts of God were necessary and miraculous. There are two main kinds of apparent contradictions between these descriptions. One difference is that the religious account refers to divine acts whereas the scientific account does not. Secondly, there are differences between the events and data that are presented by science and the Bible. The publications reviewed in Chapter 2 indicate that there are many ways to respond to the apparent contradictions between the accounts. One response is to reject one or other view; another response is to propose that God created a "clockwork" universe that operates without further intervention; a third response is to support a Theistically guided universe and to reject the claim of materialism. Fourthly it can be predicted that some students may leave the dilemma unresolved.

> The Beginning of the Universe (Science)
>
> According to the "Big Bang" theory, the universe began fifteen billion years ago as a tiny speck of incredible energy. It then expanded over billions of years to reach the vast size it is today. Scientists have deduced this because they see clues in space today that show the universe is still expanding. The dot of energy spread out, and some of the energy changed into particles of matter. Experiments in high energy colliders have shown how these "fundamental" particles could then have combined to create atoms and molecules. Gradually the material began to clump, forming stars and planets. To summarise, science can explain how the universe transformed from micro-dot to the beautiful complexity here now, using natural forces. There is no role or need for "Higher powers" in this scenario.

The Beginning of the Universe (Religion)

In the beginning, there was nothing, except for God. Even space and time didn't exist. With a miracle, God created light. He formed the light just using words by commanding it to begin. Then he created the Earth, the sky, the water on the Earth and the clouds in the sky. He put plants and animals on the Earth and fish in the sea. After each Creation, he looked at his work, and judged it to be good. The last thing to be created were people – first Adam, then Eve. The Creation happened over six days, and on the seventh day, God rested. To summarise, God created the universe with a series of miracles.

5.5.4.5 How Human Life Began

The second topic, "How human life began", focussed on the issue of blind chance versus divine action. The nature of the divine action is not specified. It could be Miraculous, Discrete or Deistic, since any of these could in theory have produced the circumstances that led to life. The religious paragraph for this dilemma refers both an allegorical and also a literal reading of the Biblical account of Adam and Eve. The important point, claims the paragraph, is that life began because God intended it to begin. It is said in the scientific paragraph that life began when a chance reaction between particles produced the first self-replicating molecule. The word "chance" is central in this discussion. Scientific Materialists interpret chance as meaning that life began by "blind chance" or accident with no divine involvement. Many of today's religious scientists argue that God orchestrated the circumstances in which life began. In their view the "chance" of life beginning was greater than zero because God intended this result to come about.

These two interpretations of "chance" are not given in the paragraphs. It was a point of interest to discover how students would interpret the term. After the interviews, I saw that this dilemma gives an unbalanced presentation of science and religion, in that more options are embedded in the religious paragraph, but only one option is apparently presented in the scientific paragraph. I address this issue further later in this Chapter (see Chapter 5.5.4.7). The kinds of solution foreseen for this dilemma were again, solutions of

solely scientific or religious origin, a Deism-Determinacy solution, or a Discrete-Operational solution.

Life (Religion)

The details of this view vary from person to person and religion to religion, but the general tenet is that God created the Earth and all the creatures on Earth. Those who accept the account in the Bible say that God created people in the following way. First he created a man, in his own image, or likeness. The man was formed from dust in the ground, and then God breathed life into his nostrils, and the man became a living being. Adam lived and worked in the Garden of Eden, taking care of the land and naming the animals. Then God said that the man shouldn't be alone. No helper could be found, so God put Adam to sleep, took one of his ribs, and made a woman from it. These days, some people don't read these descriptions literally. What is accepted by holders of the religious view, particularly the Judeo-Christian and Islamic view, is that the existence of humans was planned. To summarise, God created us. We are not the result of chance; we were planned by God to be here.

Life (Science)

Darwin's modern followers argue as follows. Billions of years ago, life began in the form of self-replicating complex chemical molecules. These molecules formed when chemicals in the oceans met by chance. The molecules were able to replicate or copy themselves. In time, more complicated organisms were formed, leading eventually to plants then animals and humans. In the struggle for survival, the most aggressive, strongest and fittest animals fared better than weaker creatures. These animals could pass on their genes to more offspring because they lived longer and could protect themselves better. Eventually humans appeared and triumphed over all the other species on the planet, as we are the most mobile, smartest and aggressive animals of all. After us, there may come another fitter species that will take our place. To summarise, we are here as the result of a chance chemical reaction that produced living, self-replicating cells. This was followed by a process of biological evolution that is powered by the survival of the fittest.

5.5.4.6 Miracles and Prayer

The paragraphs in the written dilemma about prayer focus even more tightly on the nature of science and the nature of religion.

The first important question raised is whether the natural laws that we have discovered through science restrict God's ability or willingness to make changes to the physical universe (Determinism versus theistic action). This has a practical relevancy for those who believe in God, since it raises the question, if they pray for change, is it conceivable that God would meet their requests?

The first paragraph presents a "God of the Gaps" view of religion, explaining that as we moved from an era of pre-science to one of materialism, the "gaps" that were unexplained by science and that were initially explained by calling on acts of God grew smaller and smaller. The message is that science has forced us to change our view of the nature of religion, and in particular, our understanding of the role of divine action as a direct cause of physical change.

The second paragraph "turns the tables", by looking at the ways in which religious scientists have made use of new understandings of scientific processes to show that God can discretely influence what happens in the universe.

Within this second paragraph there are a number of suggestions for how God might act in the universe in response to prayer. The first is that God can act miraculously and is not bounded by our limited understandings of how nature operates.

The second possibility that is given in the paragraph is that God needn't "break" physical laws to achieve change, especially in the light of quantum uncertainty, because He can guide physical processes imperceptibly and scientifically to enact his will. This is the notion of discrete theistic action described by many religious scientists including Berry (1996) and Houghton (1995b).

The third option is that science repudiates the possibility of any theistic action – both discreet and miraculous, and that prayers cannot hope to receive a response that involves a physical change.

With each written dilemma, the impact on religion of choosing a Deism-determinacy solution increases. In terms of the Creation dilemma, the cost of saying that God created the process that then created the planets is critical only to those who want to take a literal view of the Bible. In the second dilemma, if the process of evolution proceeds without divine action, then the existence of life in general can be said to be part of God's plan but it is difficult to see how anyone can claim that he or she is special and planned as an individual. Then, in the topic of prayer, if God never intervenes with current physical events, it seems to follow that prayers cannot be answered.

> Miracles (Science)
>
> The notion that prayers may be answered, is a hang-over from a past, pre-scientific era. In those days, spirits were thought to be the forces that operated the universe. Supernatural beings carried the Sun and the stars across the sky. It was only by the grace of these spirits that the Sun rose each morning. There were even people who thought that for rain to fall, angels had to open tiny windows in the heavenly ceiling. Since these people believed that spirits controlled the universe, it made sense to pray when they wanted something to happen. If you prayed and the gods were disposed to answer your prayer, you might get rain; you might even recover your lost gold chain – which might have been temporarily hidden by a malicious spirit. Over the centuries, our view about how the universe works has changed. Gravity explains why the planets move. Nuclear fusion explains why the Sun gives out heat. If your gold chain is lost, no amount of praying can over-come the force of gravity, lift it up and move it to a position in front of your nose. To summarise, there is no longer any room within our scientific understanding of the universe that allows for changes to be brought about by prayer. So if prayers can't achieve results, why pray?

Prayer (religion)

Many religious individuals believe God can and does answer prayers. Some of these individuals believe there is no limit to God's power. 'God makes the laws of nature and God can break the laws of nature'. If it was God's will to send an earthquake, or avert a tornado then this will happen, without obvious cause or explanation. Others say God works within the laws of nature, using a mastery of science beyond our current imaginations. For example, if we pray for rain, it is within God's power to send rain. Scientists may then search for and find a scientific explanation for why rain fell, but the bottom line is that the prayer was answered. A third view is that God answers prayers by communicating with us spiritually. When we pray, God can give us courage and comfort. A key to many religious views is the need for faith. If we have faith that God has the power and the desire to help us, then all things are possible. Thus in summary, if we believe that God can bring about change, and invite Him to do so, He will be there for us. On the other hand, if we allow scepticism to close our minds to the possibility of God, then He will be shut out of our lives by our own doing.

5.5.4.7 Bias within the Written Dilemma Texts

During analysis of the interviews, a bias was discovered in the design of the dilemmas. This bias is that the religious paragraphs in the second and third dilemma tend to present "multiple views" while the corresponding science paragraphs each only present one view. This situation arose because the content of the paragraphs was largely selected from comments made during pilot interviews and on a selection of the arguments presented by religious scientists in publications designed for the lay-public. As it turned out, these sources tended to focus on how religion can be reinterpreted in the light of new findings, while the nature of science was less frequently addressed. These ideas were left in the paragraphs because as discussed, the paragraphs were intended to offer students ideas and solutions to the apparent contradictions in addition to presenting the dilemmas.

During analysis of the interviews, the question of whether students are aware of alternative views of science and religion became an area of interest, and indeed, it was proposed that it might signify an important step in the cognitive development of

individuals. Fortunately it was possible to test this proposal by studying students' responses in an earlier section of the interview. Near the beginning of the interview (and before they read the written dilemmas) students were asked to identify topics that are common to science and religion and then to raise any apparent contradictions in these topics. Students were asked at this time whether there are contradictions that others perceive but which they themselves did not perceive. The answers to these earlier questions were used to examine the proposal that students occasionally indicate an awareness of multiple views of religion, but do not indicate that they are aware of different views of science. Two students identified contradictions that they said were apparent-only and in both cases, these apparent contradictions referred to different ways of interpreting the Bible. (This finding was first reported in Chapter 6.6).

There was a second opportunity to test the proposal via an additional set of interviews with a second sample of 20 students. For this second study, the written dilemmas were all written in such a way that each paragraph of scientific and religious information presented a single view.

5.5.4.8 Which Views are Available to Students?

In the research that Schneller conducted in 1982, described previously, students were offered a selection of responses that were drawn from the academic literature and were asked to select one. In this research, a less restricting methodology was adopted. Students were asked to identify apparent contradictions themselves and to construct their own responses to them. As discussed, some of the approaches taken by academics were suggested within some paragraphs, but students were not required to take these.

5.5.5 Further Design issues

5.5.5.1 Sensitivity to Students' Peace of Mind

Ethical issues were considered carefully when planning this project. Since the debate over whether there is life after death can unsettle some people, it was decided to exclude this topic from the list. If students raised the topic during the interview, they were left to complete their response without interruption, but were not questioned further on this topic.

One reason for interviewing only tertiary students and for not widening the age range to include school students was that it was considered that some of the questions might unsettle adolescents, especially if they had not previously considered the possibility of contradictions between science and religion.

CHAPTER 6
PRELIMINARY ANALYSIS OF THE TRANSCRIPTS

6.1 Introduction

This chapter reports the findings of a preliminary round of analysis that was qualitative and wide-ranging. The following four chapters (Chapter 7 – Chapter 10) describe the development of a number of more systematic analysis systems that were then applied to the interviews.

The purpose of the Preliminary Analysis was to identify the factors that might be relevant in a description of the approach that a student takes on encountering a topic containing apparent contradictions. It was explained previously that reporting on students' beliefs would only be of limited value and in particular would not reveal how those beliefs were arrived at. By describing students' approaches (using terms yet to be decided) it was hoped to distinguish between students who made a particular decision having considered the alternatives and students who had unquestioningly accepted a viewpoint from their parents or teachers.

This chapter thus sets the scene for the work that is to come. While studying the transcripts and while remaining open to emerging issues, a number of key questions relating to the theme of the project were also kept in mind:

- Are these tertiary-level students generally aware of the possibility of contradictions between science and religion, bearing in mind that Goldman (1964) interviewed secondary school students who had not compared their religious and scientific beliefs?

- Do the students predominantly see science and religion as containing contradictions (the conflict view) or do they largely see the relationship as harmonious?

- In general, are the students discussing the same kinds of issues as those that are discussed in the literature, or are their approaches seemingly very different?

6.2 A Preliminary Phase of Analysis

In qualitative studies, researchers tend to use inductive methods to analyse the data, meaning that the critical themes emerge out of the data (Patton, 1990). When searching for patterns, the researcher holds in mind how the data within each interview transcript is relevant to the research question (Smith, Thorpe, and Lowe, 2002). Bogdan and Biklen describe the process as involving:

> working with data, organizing it, breaking it into manageable units, synthesizing it, searching for patterns, discovering what is important and what is to be learned, and deciding what you will tell others.
>
> (Bogdan and Biklen, 1982, p. 145).

Yates (2001) describes a range of different approaches to analysing qualitative data. For this study, for the preliminary analysis stage, phrases, responses and portions of responses were copied electronically from each transcript and were placed in "thematic categories". The thematic categories were like holding bays for comments that seemed important but which could not yet be systematically arranged. Students' descriptions of the general relationship between science and religion were collated into one such category.

These categories were then modified in a series of rounds of studying, sorting and coding the data, a process used in many qualitative studies (Yates, 2001).

When forming the categories, the data obtained through interviews are organised "with an ear for what informants are saying rather than an eye on predetermined categories and hypotheses" (Kidder & Fine, 1997: 47). There are numerous ways that the data can be

organised, and the construction presented by one researcher is not necessarily the one that another researcher would devise (Patton, 1990).

This method of analysis was chosen to overcome an issue that made it difficult to analyse the transcripts. The difficulty was that students used their own words when they gave their answers and so their responses were rarely identical. Until the methods of analysis were reasonably well developed, it was useful to work with quotations so that when factors were speculated to be important, the students' words was there in their original forms and had not been inadvertently distorted during a summarising process.

Figure 2 shows examples of the thematic categories that were developed.

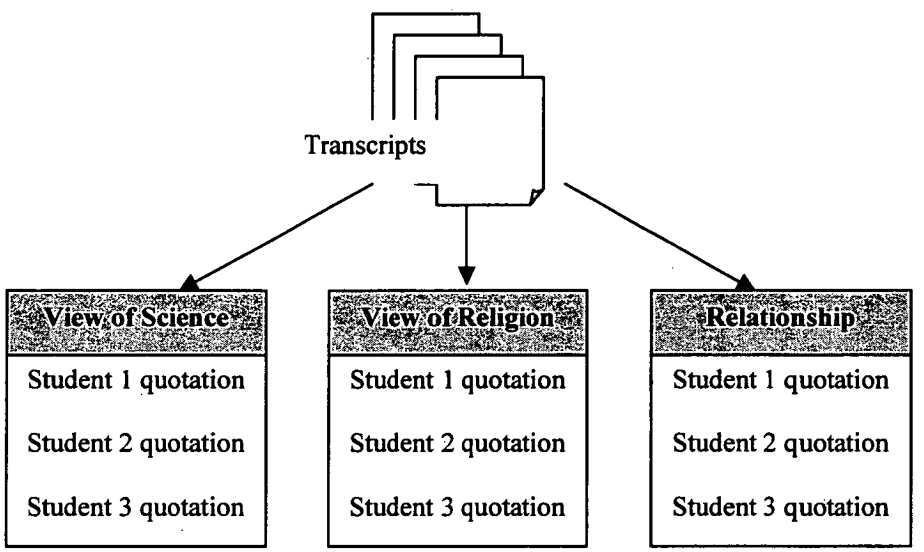

Figure 2. Examples of thematic categories.

The quotations in the categories were displayed in two ways. Using Microsoft PowerPoint, an A3-sized template was created with an arrangement of empty text boxes. The template was copied and filled in for each student using the selected quotations. This was a very visual way of working with the transcripts because the text boxes could be moved into different arrangements on the page.

In addition, copies of the quotations were maintained in tables in Microsoft Word. This was found to be a convenient way to compare the responses made by students on similar themes.

The process was iterative and the categories are formed and refined during repeated readings of the transcripts. Rules of analysis were formed during these iterations and earlier transcripts were recoded to ensure consistency.

6.3 General Findings

The remainder of this chapter presents a qualitative review of the findings that emerged from the analysis. In Chapters 7-12 a systematic analysis system will be described that produces meaningful descriptions of students' approaches using selected items of information.

6.3.1 Range

When the interview transcripts were studied, it was immediately apparent that students presented their beliefs about the topics in individualistic ways. There were variations between ideas they expressed, the words they used, and the extent to which they were troubled by the apparent contradictions.

This may be because there is little formal teaching on this topic and so students rarely have an opportunity to study or share their ideas. Students form their own opinions and approaches based on the information that is available to them.

6.3.2 Consistency during the Interview

At different points in the first half of the interview, almost all the students spontaneously made comments about how they respond in general to apparent contradictions between science and religion. These comments were compared with the comments that students

made when they responded to the written dilemmas. In most cases, the degree of consistency was notable given that Fysh and Lucas found in contrast that senior school students showed "unexpected complexity and apparent internal inconsistency" within their individual personal views (Fysh & Lucas, 1998b, p. 63). The students in the current study are older than the students in the study by Fysh and Lucas and this might be one reason why their views are more consistent.

The examples in Table 5 show students making general comments in the early section of the interview, and then specific comments in the written dilemma section that have similar themes.

Table 5

General Views Compared with Responses to Specific Topics

MU4 in General section	**MU4 on Life**
I have a rational view, which causes me to discard the religious view in favour of science.	Once it's explained scientifically, it shatters the religious view.
MU5 in General section	**MU5 on Creation**
I try to adapt them to each other without totally disregarding the other.	I think there was an overall plan and things happened in the scientific way. I'm trying to resolve the two together. I want to hold onto both.
MU30 in General section	**MU30 on Life**
They're not completely opposite nor exclusive. There is a way to combine them but I'm not sure how. You have to look at religion in a different way, knowing science. I think God created science.	I try to adapt them to each other without totally disregarding the other. I don't believe you have to have one or the other. God made evolution or God allowed us to evolve.

6.4 Students' Views of the General Relationship

6.4.1 Awareness of Apparent Contradictions

One of the points of interest in this study was to discover whether there are students who retain a "dualistic" perspective beyond their school years. In his descriptions of the views of schoolboys in the 1960s, Goldman observed that some students held contradictory beliefs without realising that they do so. Goldman proposed that these students operated with dualistic frameworks – a religious framework and a separate science framework (Goldman, 1964).

In the interviews carried out for my study, one of the 20 students, MU8, said that this was the first time that she had compared her religious and scientific beliefs. When this student examined her beliefs during the interview, she discovered there were contradictions in her beliefs. Selected quotations from the transcript of this interview are given in Table 6.

Table 6

Selected Quotations from the Interview with MU8

MU8 in General section	**MU8 on Creation**
I haven't thought about them together before. Now I think they are linked. I used to think they were separate.	I was taught to believe both of them and I haven't formed my own belief. They're two totally different views. Either something greater made us, or evolution made us from mud. It's too hard and you can't bring them together. **MU8 on Heaven** My beliefs are in two different areas. I've discussed heaven a lot but only from a religious aspect. I need to sit down and take a closer look.

These quotations show that at the point that she began the interview, this student's view was a dualistic one. It follows that the dualistic view does in some cases persist beyond school age. Having discovered the apparent contradictions during the interview, this student moved to an approach of comparing and evaluating the assertions.

Another student, MU34 also made comments during the interview that indicated she had recently held dualistic views, at least on some topics. She initially described the relationship between science and religion as harmonious, saying:

> I haven't been forced to question everything I believe... and I've been able to say, yeah, there's no contradiction still for me.

When she studied individual topics, however, she identified contradictions between the accounts, which she describes as "real contradictions".

The other 18 students were clearly aware of the viewpoint that science and religion contain contradictions, and had at some point reflected on their own views on one or more topics.

6.4.2 Students' Views of the Real Relationship

The issue of the "relationship" between science and religion, and the options that exist to describe it, such as "conflicting", independent" and "complementary" are central in discussions of science-religion dilemmas (see Chapter 2).

During the interview, two questions focussed on the students' views of the relationship. These were:

- How would you describe the relationship between science and religion?
- Some people say there is conflict between them. What do you say about this view?

Two of the 20 students said that science and religion contain no contradictions. These students were later found to have had very little exposure to the apparent contradictions that exist. One student said:

> "I guess because I haven't done a lot of science studies, I haven't been forced to question everything I believe... and I've been able to say, yeah, there's no contradiction still for me" (MU34).

The majority of students saw science and religion as containing many contradictions. Some students even said they were mutually exclusive. I had predicted that most religious students would maintain that science and religion are in harmony, and would support the validity of both disciplines. This was not the case. Most students who were religious said that there were contradictions between the fields.

The approach of Assimilation has already been described. It is the approach in which traditional religious assertions are reformulated to fit better with mainstream science, which in turn is said by some not to oppose discrete theistic action. As explained, it is usually said by the religious scientists who adopt this approach that the reformulated religion is the "real" religion, and that the "real" relationship between science and religion is harmonious (see for example Peters, 1998).

The descriptions that students gave of the relationship are summarised below in Table 7. Selected quotations by students together with the coded relationships are given in Appendix E.

Table 7

Students' Views of the General Relationship

Generalised Relationship	Student ID	No. of Students
Unaware of any Contradictions	MU8, MU34	2
Declined to answer	MU3	1
They needn't contradict	MU9, MU29, MU30	3
A clash, but it depends on how you look at it.	MU5	1
Real contradictions	MU4, MU6, MU7, MU17, MU20, MU21, MU27, MU28, MU32, MU33, MU35, MU36, MU37	12

Within this sample, three students expressed the view that "there needn't be contradictions", which seemed to be a noteworthy response and one that was difficult to interpret without further analysis. The view of the student MU5 was similarly circumspect, but seemed to edge on the side of contradiction. Most students indicated that there were many real contradictions. A few went further and indicated that science and religion are exclusive, like "chalk and cheese" in the words of MU6. One student, MU3, was unwilling to give an opinion on whether there were contradictions, saying that it depended on whether you wanted to look for contradictions, and that such questions are unanswerable.

6.4.3 Students' Views of Science and Religion

When students described science and religion, they used lay terms rather than the kinds of terms presented in the literature (such as scientific materialism). It was noted that science and religion were often described in contrasting terms, such as: "Facts versus ideas" and "Laws versus beliefs". A categorisation of students' responses is given in Appendix D. Further analysis of these responses is presented in subsequent chapters.

6.5 Students' Approaches to Dilemmas

6.5.1 The Approach of Seeking to Combine the Accounts

In their generalisations, there were five students who said they sought to combine the information from science and religion on mutual topics. The process of combination was described as a struggle in the face of a difficult relationship:

> "Often they tend to clash" (MU5).
>
> "They contradict" (MU21).
>
> "There are some contradictions" (MU30).
>
> "There are contradictions but they can be made to fit" (MU32).

It seemed that although these students favoured an approach that resembled Assimilation, they did not see this as a way to remove all the contradictions. There are several possible reasons why these students saw the "real" relationship as contradictory. Perhaps they saw the "real" religion as the literal version and the reformulated version as an unsatisfactory compromise. Another possibility is that these students had been taught the final view, and do not realise that it resolves the apparent contradiction. Thirdly, perhaps they were not comfortable with reformulating religion to factually fit with science. These are the kinds of questions that will be addressed in the forthcoming chapters.

6.5.2 Dualistic Strategies

The qualitative analysis revealed that some students took approaches that were very different to the expert approaches described in the formal academic literature. The approach taken by MU6 was a striking example. This student explained that even though she was aware that two statements were contradictory, this did not prevent her from believing both, albeit at different times:

> "If I'm thinking about religion, I take a religious kind of view, but if I'm thinking in a science way, I take the science view" (MU6).

This finding highlighted the need to develop a category system of students' approaches that was able to encompass approaches that were not described in the formal academic literature.

6.5.3 The Strategy of Disengaging from a Dilemma

Prior to this study, a prediction was made that the perception of unresolved contradictions would be a source of tension. As it turned out, the degree of tension across the group regarding unresolved contradictions was lower than might have been expected.

There were four students, for example, who stated that they were aware of unresolved contradictions, but who indicated that they felt no tension about the existence of these contradictions and held no desire to resolve them:

> "I don't have answers but I'm quite comfortable; I'm not searching for anything" (MU9);

> "I haven't resolved it. There's no tension for me personally" (MU35).

Closer examination of the transcripts revealed why these students did not feel tension over the existence of unresolved contradictions.

One student explained that she had attempted to resolve the contradictions in the past, but was now resigned to the conclusion that a clear answer is not available. In this resigned state of mind, it seemed that her feelings of tension were reduced:

> "I used to want answers. Now I don't have to have an answer for those sorts of things any more, like I used to" (MU6).

This student also explained that on a day-to-day basis, she did not experience tension because she found herself alternating her view of the world, depending on her circumstance:

> "They have different points of view so it's hard to put them together. If I'm thinking about religion I take a religious point of view. But if I'm thinking in a science way, I take the science view" (MU6).

Another reason that students gave for a lack of tension was that the student felt that knowing the answer to the dilemma would make no difference. A clear example of this view came in the second set of interviews, in which one student MU59 explained:

> "I am content not to know. It's not a source of tension because I don't think about it. It's not relevant to me and my daily existence" (MU59).

Another student in the second set of interviews explained that she was fascinated by the questions discussed but has settled on the approach of waiting for other people to resolve them, rather than engaging in reflection herself:

> "I'm interested but I feel like a spectator. I'm watching to see which ones wins. I'm not interested in resolving it. It's just interesting" (MU67).

The two common features of the approaches described by these students were that if they had a choice, they did not reflect on science-religion dilemmas when they encountered them and secondly that they did not feel tension over unresolved contradictions, although aware in a general way of their existence.

6.5.4 The Strategy of Disengaging with Fixed Beliefs

There was another group of students who said they did not ordinarily focus on the issue of apparent contradictions when they encountered science-religion topics. Four students, including MU4, indicated that they had made a global decision to seek information only from either science or religion eschewing other sources, and thus did not feel it necessary

to look in detail at the two sides of the debate on individual topics. Their responses caused some deliberation during the analysis process. Initially the students seemed to be saying that they had resolved all the apparent contradictions. In fact, however, they had resolved the question of what to believe on these topics without reflecting on the contradictions within the topics.

When he was asked whether he personally perceived there to be contradictions between science and religion, MU4 said:

> "Not personally... living in an era that is so dominated by science and rationality and looking at things intellectually I don't think I will ever adopt a religion. I look at the majority of religious teaching as parables and myth, a way to tell stories. I lean towards science I guess".

The qualifiers in the student's comments, such as "I guess" make it difficult to say with certainty that this student never seeks out and reflects on the contradictions within specific topics when he encounters science-religion dilemmas in everyday life. In the written dilemma section of the transcript, however, the students' willingness to engage in reflection on the dilemma could be studied more directly. It was noted that this student accepted the task of identifying apparent contradictions within two of the three written dilemmas.

There were several students who said they had globally rejected religion or science. The reasons they gave for their decisions varied. Some referred to science or religion fading through apathy and some referred to a conscious decision to reject one or other viewpoint, made after a period of reflection.

MU4 made what he described as a rational decision to globally reject religion on the basis that he found its claims unbelievable, given that they were not backed by evidence:

> "I have a rational view, which causes me to discard the religious view in favour of science" (MU4).

A similar view was expressed by MU17:

> "Over the years science has disproved a lot of supernatural ideas. That destroys religion" (MU17).

Contrastingly, MU36 explained that his rejection of religion had come about gradually on the basis that the explanations provided by science seemed to be sufficient. He said:

> "I don't really have any religious views. My religious views evaporated for different reasons, not because of science. I didn't sit down and think, because the two conflict, I have to choose one or the other" (MU36).

The student, MU37, also said she rarely reflected on the contradictions, having made a global commitment to religion and a global rejection of science. When she generalised about her approach, she said:

> "Religion plays a bigger part in my life. There's conflict but I'm not a science-based person so I don't think about it much." (MU37).

Once again, these self-descriptions of their strategies were made during the first section of the interview. When these students arrived at the dilemma section of the interview, most agreed to identify and discuss the apparent contradictions between the texts that were presented.

6.5.5 References in the Literature to a Lack of Concern Regarding Unresolved Contradictions

The finding that many students are untroubled by the apparent and unresolved contradictions is supported by previous research, for example it was one of the results reported by Fysh and Lucas (1998a, 1998b).

Schneller also reported that students frequently chose to avoid rather than confront the contradictions on the basis of his study with senior school students. In Schneller's study Students were offered a choice of five ways to approach apparent contradictions Schneller reports that:

> many students prefer to "flee" a cognitive confrontation with the problem...
>
> (They) would rather choose the affective-general approach which does not require dealing with the details of the potential problem.
>
> (Schneller, 1982, p. 271)

In Schneller's research, choosing the Affective approach was the only approach that students could select to avoid the contradictions. In Schneller's methodology, students were presented with a set of options for replies. These options did not include, "Leave the issue unresolved" and "reject the religious view outright". In my own study, students constructed their own replies, and many said outright that they chose not to address the contradictions.

Altogether 40 students were interviewed for this project (two samples of 20 students). The reasons that were given by the entire group for disengaging without resolving the dilemmas can be summarised as belonging to four types:

- Spectator (takes an interest in other people's efforts to find solutions but does not personally seek solutions);
- Delayed (has made a conscious decision to postpone attempting to resolve the dilemmas until another time in life);
- Resigned (expresses the view that we will never have solutions and it is a waste of time to attempt to resolve the dilemmas);
- Not interested (is not interested in having solutions to the dilemmas).

Some of the ways in which students responded to the dilemmas, having opted to disengage from reflecting on them, were:

- Alternation (alternates between beliefs depending on circumstances);

- Knowingly Illogical (believes both, knowing they contradict);
- Unresolved (lives without a solution to the dilemma).

These lists are not complete in that further interviews would probably reveal additional reasons and additional ways of maintaining the approach.

6.6 Perceived Contradictions in the Spoken Dilemma Section

In the spoken dilemma section, students were asked to identify topics that are common to science and religion themselves. The section came at an earlier point in the interviews than the written dilemmas so that it is known that at this point, students' ideas had not been influenced by the way that the dilemmas were presented.

In the spoken dilemma section, then, students were first asked what topics are common to science and religion. A list of the topics identified by students is given in Table 8.

Table 8

Topics Identified as Covered by Science and Religion

Topic	**Number of students who listed this topic**
Evolution / Origins of life	15
Creation of world	5
Why we're here. Life's purpose	4
Abortion	4
Life after death	2
Contraception	1
Genetic engineering	1
Turin shroud	1
Core values: science says whether something is true and religion says whether it is good or bad	1

As Table 8 shows, the three topics that students most commonly raised were the origin of life, which was raised by 15 students; the beginning of the universe, which was raised by 5 students, and the purpose of life, which was raised by 4 students. It is worth noting that the three topics that were most frequently raised by students are also ones that are also widely discussed in the publications written by academics (Ashton, 2001; McGrath, 1999; Murphy, 1990; Peacocke, 1996; Peters, 1997; Polkinghorne, 1998b).

One of the aims of the preliminary analysis of this section was to discover how closely students' views matched the views described in the academic literature. Given that students and academics raise similar topics as one deserving further study, the question then was, were the contradictions that students identified for these topics also similar to those identified in the literature?

To address this question, an examination was carried out of students' views regarding the question that was most commonly raised which was the question of how human life began. A review of the publications by academics indicates that the role of divine action is perceived to be the key issue for this topic (Ashton, 2001; McGrath, 1999; Murphy, 1990; Peacocke, 1996; Peters, 1997; Polkinghorne, 1998b). An additional issue that is widely raised is whether references to Biblical events should be read literally.

The 15 students who identified this topic were asked whether they were aware of any contradictions between the scientific and religious accounts on this topic. All 15 students identified a contradiction. In each case, only one contradiction was described, with varying wording.

In the contradictions identified by six students, the wording indicated that these students did indeed perceive a contradiction regarding the involvement of a divine act. Examples were:

> "In the religious view, someone created things. In the scientific view, it wasn't any one person's idea" (MU5);

> "In science there doesn't seem to be a why about it, just that we are" (MU9);
>
> "One is saying everything started by itself but the religion one is there was a divine plan" (MU20).

The other nine students presented what will be labelled "wordy contradictions" and "terse contradictions" for this topic. A terse contradiction was a brief statement to the effect that the two accounts are "just different" (MU32) or "are exclusive" (MU6) with no more detail given. Those who presented wordy contradictions did not specify the nature of the contradiction, but instead gave a summary of one or both viewpoints, for example:

> "Science says humans evolved from apes over time and religion says there was Adam and Eve and the garden. Eve was made from Adam. They're two completely different views and you have to choose which to take" (MU28).

On the basis of this analysis, it was concluded that some students were identifying types of contradictions that are also raised in the academic literature, while others were identifying types of contradictions that were notably different in nature.

Students were then asked whether there were any issues on which other people might perceive a contradiction but which were not real contradictions in their minds. At this point, several students talked about disengaging from the task of thinking about contradictions which they described as a way of resolving the problem. Through supplementary questions students were asked to change focus and indicate whether they were aware of differences between the accounts that some but not all perceived as contradictions. At this point, two students, MU5 and MU30 said that the literal existence of Adam and Eve was an example of such a contradiction.

6.7 The Written Dilemma Section

At the time of the preliminary analysis there was not a systematic way to analyse students' responses to the written dilemmas. This issue is revisited later in this thesis.

This section discusses a more general issue that emerged as an important one via the analysis of the previous sections of the transcripts, which was the extent to which students engaged in reflection on the dilemmas.

In the written dilemma section of the interview, three of the four students who had expressed a general lack of concern about their perception that science and religion contain contradictions took up the task of seeking apparent contradictions between the accounts. (One could imagine they were still somewhat unconcerned about these topics but had agreed on request to engage in the task.)

The student MU3 expressed a high degree of indifference throughout the interview. This continued in the dilemma part of the interview, illustrated here by her comment when she was asked whether there are contradictions between the religious and scientific accounts describing how life began:

> "I think a more important question is, does it matter? ... It doesn't matter how we got here and we'll probably never know" (MU3 on Life).

A similar comment was made by the student MU9:

> "I don't have a view. It's not something I think about. We're here now" (MU9 on Life).

In the cases of each of these two students, their lack of interest in having answers to these questions resulted in the student disengaging from the task of seeking out contradictions in one or more of the dilemmas. This is despite the fact that in the dilemma-part of the interview students are specifically asked to seek out contradictions. These two students were among those who had said previously that there "needn't" be contradictions between science and religion. This comment might have been intended to mean that there needn't be contradictions if you choose not to look for them.

6.8 Comparing Students' and Experts' Views

The preliminary review of the transcripts indicated that the approaches taken by students were not similar enough to those described in the academic literature to allow the students' responses to be placed directly into the typologies designed by Barbour (1988) or Polkinghorne (1988a).

For example, in the schemes by Barbour (1988) and Polkinghorne (1998a) the approaches that describe the search for a combined belief are Assimilation, Integration and Consonance. These approaches are all based on the principle that "real" science and "real" religion do not contradict. As shown, some students indicated that they sought beliefs that combined science and religion, but they described the overall relationship as contradictory. Thus, their approaches were evidently not Assimilation, but there were some similarities with this approach.

In some cases, students took approaches that were clearly very different to those described in Barbour's typology. The approach by MU6 of alternating her beliefs depending on her situation is a striking example. Looking at the approaches in which students opted for a belief based on science only or religion only, there were also some noticeable differences between the academics' and students' approaches. While some students based a decision to reject science or religion on rational grounds, another explained that she was "biased" and in one case, a student explained that the reason why he supported a science-only perspective was because his religious views had "evaporated" through inattention. Again, these approaches cannot all be contained within the categories of Barbour's typology.

6.9 The Effect of Science on Faith

Three students in the sample of 20 described themselves as atheists (they said they did not believe in God); seven described themselves as agnostic (they said they were undecided as to whether God existed); ten described themselves as religious (they said they believed in God – allowing for moments of doubt).

Students were asked how much effect they thought science had had on their religious faith. Only four students said they felt it had had a significant effect. Interestingly, however, these students were ones who had described themselves as agnostics or as religious. Thus although these students stated that science had significantly affected their faith, it clearly had not caused them to dismiss it entirely.

The three atheists in the sample said science was not the main reason why they had rejected religion. They explained that the most significant effect on their religious faith was being born into a non-religious family. It was only in a second sample of twenty students that a student was found who claimed that science had challenged his faith to such an extent that he felt obliged to give up his faith.

6.10 Changes that Take Place during the Interview

During the interviews, there were a number of occasions on which students modified their views, or stated they had not previously considered particular aspects or arguments. Some of the changes seemed to be a kind of "settling effect": a student would state an idea but without confidence, would then qualify this statement and in so doing would then settle on a slightly different idea. In this example, the student was asked to summarise what religion and science tell us about the Creation of life, and was then asked whether there were contradictions between the views:

> "There's not in some ways ... well, I suppose there is, in that evolution says that man came about in the same ways as everything else and religion says that man came first and then the rest of it" (MU7).

On other occasions, some students indicated that they were now becoming aware of issues that they had not previously considered. As a result, in some cases, students raised and discussed more issues as the interview progressed. This was particularly notable when there were topics that recurred at different points during an interview.

6.11 Level of Interest in Science-Religion Topics

Eighteen of the 20 students made comments that indicated they were interested in the subject matter of the interview. These were made when the purpose of the research was explained and through expressions that indicated that they found the ideas presented in the written dilemmas interesting. The last question in the interview asked students whether they were still seeking ideas in this area. Seventeen of the 20 students said that they were. These findings are comparable with the report by Campbell & Curtis (1996) that more than seventy-six per cent of Australians think about the "meaning of life" sometimes or often. Thus although about half the students in the sample said that they sometimes chose to disengage from thinking about these kinds of dilemmas, it does not appear that this strategy is taken because students are uninterested in the subject matter. One reason for taking a strategy of disengagement might be that it allowed students to avoid thinking about problems that they believe cannot be resolved in a satisfactory way using the strategies and information available to them. Another possibility is that students believed that the dilemmas had been resolved and that no further reflection was necessary.

6.12 Chapter Conclusion

The Preliminary review of the transcripts indicated that most students in the sample were aware of apparent contradictions between science and religion. This said, in at least one case, a student was clearly unaware of the apparent contradictions when she began the interview. Another two students were unaware of the apparent contradictions within their beliefs on some topics. One of the findings of this research was that the mental state of dualism, described by Goldman (1965) occasionally persists into the tertiary education stage.

The approaches taken by students were judged to be different to the approaches described in the literature and some approaches were judged to be markedly different to the ones described in Barbour's typology. An important finding was that many students chose to

avoid thinking about science-religion dilemmas when they encountered them. This approach was taken by some students as a way to reduce the tension that might otherwise have been felt.

It was also found that some students made their decisions about what to believe for a given topic on the basis of a global decision to reject science or religion. The finding that some students made their decisions about what to believe without considering the issue of apparent contradictions between accounts indicated that when describing students' approaches, the way that the student thinks about the apparent contradictions is only one aspect and may not be a part of the approach at all.

Given that many students said that they ordinarily avoided thinking about science-religion dilemmas, it was considered important to note that the design of the written dilemma section of the interview placed students in a particular and perhaps unusual situation in that they were specifically asked to identify and discuss the apparent contradictions within topics. This resulted in some students taking an approach that was different to the one they initially described as a Free Choice-Choice approach. Many students who said that they ordinarily avoided reflecting on the apparent contradictions agreed to take on the task of attempting to identify contradictions when they were asked to do so.

In the cases in which students did identify contradictions, these contradictions seemed to relate to the themes identified in the literature as giving rise to apparent contradictions.

In the chapters that follow analysis systems are devised that address these themes in more detail.

PART 4: DEVISING THE INTERVIEW ANALYSIS METHODS

CHAPTER 7

TYPOLOGY OF WRITTEN DILEMMA APPROACHES

7.1 Introduction

This chapter describes the derivation of a set of five categories that were designed to describe the different approaches that might be taken by students to the written dilemmas. It also describes a set of categories to describe the approaches that students said they took when they generally encountered science-religion dilemmas.

These two category systems were based on different sections of the interview transcripts. The typology of Written Dilemma approaches drew on the section of the written dilemma section of the interview. In this section, students were asked to identify apparent contradictions between two paragraphs of text for each of three topics. One of the values of this part of the interview was that all the students studied the same material and addressed the same questions, which simplified the task of comparing their responses.

The typology of Free Choice approaches drew on an earlier part of the transcript in which students gave self-descriptions of how they usually approached science-religion dilemmas before the interview.

There is a third section within the format of the interview in which students identify dilemma topics themselves. This is the Spoken Dilemma section, in which students identified topics common to science and religion and were then asked to discuss apparent

contradictions. A typology was not developed for the approaches that students took regarding the Spoken Dilemmas.

7.2 A Meaningful Description of an Approach

A central question in this research was the question of what would constitute a "meaningful" description of a student's response to a science-religion dilemma. It was realised early in the research that describing students' beliefs alone would not convey the depth of students' reasoning. Beliefs may be learnt, or they may be the result of reflection and decision-making. A child may be taught for example that the Creation story of Adam and Eve is allegorical and may never consider the possibility of a literal interpretation. A more satisfactory description would surely indicate how students arrived at their beliefs.

Early in the project, the term "approach" was chosen as the label for a working construct that would eventually describe how individuals arrived at particular conclusions, given the apparent contradictions. The ongoing challenge was then to decide what information should be given in each description of an approach.

One of the first questions that arose was whether the function of the approach should be to describe how students think about the relationship between science and religion in general; how they think about science-religion dilemmas; or how they think about individual apparent contradictions.

The first kind of interaction in this list is the interaction between science and religion in general, or what can be called the "general relationship".

Barbour (1988) constructed a four-fold typology of philosophical positions that may be adopted regarding how to relate science and religion in general. The point was raised previously that many students seemed unaware of the kinds of philosophical issues that are relevant in discussions of the general relationship. For this reason, Barbour's typology of general relationships was not used as a basis for the typologies that were developed here.

The third possibility was the idea of describing students' approaches at the level of individual contradictions. An example of an individual apparent contradiction is: "Life began by chance; life began by an act of God." The disadvantage with this framework is that it would limit the scope of the research and exclude a discussion of what had emerged as a particularly interesting finding about laypeople's approaches. From the preliminary analysis, it was known that some students chose to avoid the issue of apparent contradictions, and that they did this for a range of reasons. This is a point of interest for the research because it highlights that there are approaches taken by laypeople that are different to the approaches described in the academic literature. If the scope of my study was only to look at their responses to apparent contradictions, then all of these students would be categorised as taking the same approach – which is that they did not identify any contradictions. If, however, the scope of my study was broadened to look at "students' approaches to dilemmas" this would include looking at why some students avoid confronting the issue of the apparent contradictions.

The direction chosen, then, for this study was that it would explore students' approaches to science-religion dilemmas. As such, descriptions of students' approaches would include a description of the decision about whether to engage in seeking apparent contradictions within a given dilemma.

7.3 Initial Difficulties

The two typologies that will be described in this chapter came after many other categorisation systems were devised, tested and rejected. An early method that was employed was to seek natural and meaningful groupings in students' responses to the Written dilemmas. In the written dilemma section of the interview, students were presented with three set dilemmas and were asked to identify and discuss the apparent contradictions in each. The aim was to devise categories of approaches that represented different ways of arriving at a belief for the dilemma. Numerous sorting criteria were developed and tested, including labelling the approaches according to the students' final beliefs; looking for alignments in the rationales they gave for their decisions; ranking the

student's levels of tension and ranking their familiarity with the topics. These rounds of analysis produced some insights but none of them led to a comprehensive set of categories that was judged to be sufficiently meaningful. The issue with basing a category system on students' beliefs has been mentioned – it does not explain the more important issue of how students arrived at those beliefs; the rationales appeared highly individualistic; each student's familiarity with the problem and level of tension could easily be rated and categorised, but these did not seem to be sufficiently meaningful groupings for the purpose of explaining how students arrived at their beliefs.

7.4 The Typology of Free Choice Approaches

In an interim bid to understand in a simple way how students made their decisions, attention was turned to the section in the interview in which students described their general attitudes towards science-religion dilemmas. This was the part of the interview in which students discussed the general relationship between science and religion and whether they experienced tension as a result of the widely perceived clashes between them. Students also explained why they felt the level of tension they described. The relevant questions are numbered 1.4-1.6 in the interview schedule, which is presented in Appendix A.

Examples of students' responses are given below:

> "If I'm thinking about religion, I take a religious kind of view, but if I'm thinking in a science way, I take the science view" (MU6);
>
> "I haven't thought about them together before. Now I think they are linked. I used to think they were separate" (MU8);
>
> "I don't really have any religious views. My religious views evaporated for different reasons, not because of science" (MU36).

These self-described approaches offered a relatively accessible insight into students' thinking, although it is acknowledged that self-descriptions can be unreliable. In contrast the students' responses to the set written dilemmas offer a more detailed and direct view of students' responses to dilemmas, but are more difficult to dissect.

The responses that students gave about how they usually respond to science-religion dilemmas were grouped to highlight similarities and differences between them. In this way, categories emerged in a way that is typically described as taking place in a qualitative research project (Brenner, Brown & Canter, 1985; Seidman, 1991).

Based on this analysis, it was concluded that there are five ways in which students usually respond to science religion dilemmas when they meet them in circumstances in which they can choose freely whether or not to engage in reflection about the dilemma. The five Free Choice approaches are:

- Free Choice Unconnected approach: Individuals are unaware of the potential for contradictions, having never held the information presented by science and religion on common topics in common attentional focus;

- Free Choice Disengaged approach with fixed belief: On the basis that they have established what they believe about a particular topic, individuals say that they do not need to reflect on science-religion dilemmas. An example of an individual who may take this approach is someone who has globally rejected science or religion and whose beliefs are based on assertions from the remaining source alone.

- Free Choice Disengaged approach with undetermined belief: Although individuals are able to compare the accounts independently, they choose not to think about these dilemmas, and do not have fixed beliefs on the topics in question.

- Free Choice Juvenile approach: Individuals cannot compare the information presented by science and religion independently. (This category was based on several students' descriptions of their responses to science-religion topics when they were young.)

- Free Choice Engaged approach: Individuals can compare the information from science and religion without assistance and generally engage in thinking about these kinds of dilemmas when they arise.

7.4.1 General Comments

As explained previously, the typology was drawn by studying the collation of students' self-descriptions of their general approaches to science-religion dilemmas. The categories focus on the first major decision that a student makes on encountering the dilemma, which is whether to engage in reflecting on it. The aim when designing the Free Choice typology was to have a set of categories that would delineate between students who said they generally engaged in reflecting on dilemmas and students who said they did not.

Once drafted, the categories were refined to ensure they covered all the different attitudes that each student might hold regarding whether to engage with a dilemma. Figure 3 shows that the five categories appear to produce an all-encompassing set.

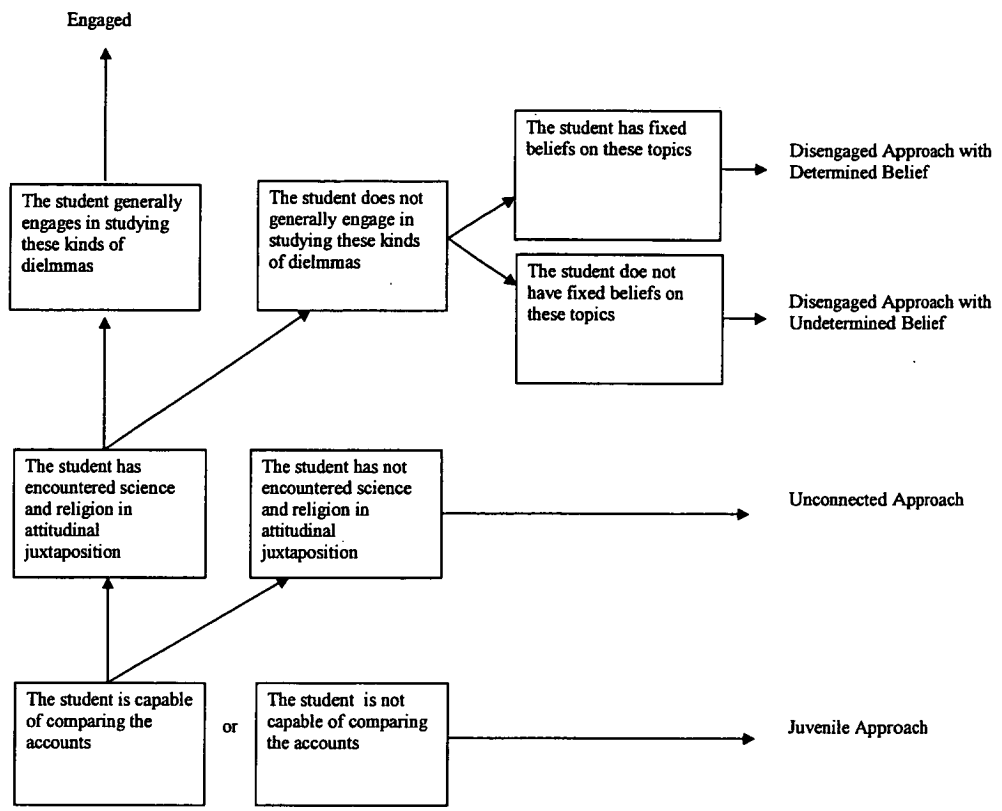

Figure 3. The Free Choice approaches

The five categories given here were drawn from students' self-descriptions of how they felt about science-religion dilemmas prior to the interview. In these self-descriptions, students did not refer to one instance of time, but to their general stances or attitudes. Thus the approaches in the typology each refer to a generalised attitude, rather than to a specific situation. As a result the boundary between the categories of "generally disengaged" and "generally engaged" is not clear-cut. This is an issue when using the finished typology as an analysis system to study the transcripts. There is a degree of uncertainty when making some classifications, especially in the cases in which students referred to holding more than one attitude at various times.

In contrast, when devising a related typology to classify the students' approaches in the written dilemma section of the interview, the categories can be tightly defined. This is because in the written dilemma section of the interview, students discussed each dilemma

separately and so the typology and the available data are both dealing with students' approaches to one dilemma at one time. As will be shown this enables the production of five categories that are arguably discrete and logically complete.

In the paragraphs below, the Free Choice approaches are described in more detail.

7.4.2 The Juvenile Free Choice Approach

This category describes the approaches that are taken by young children who are not yet sufficiently cognitively advanced to compare the information from science and religion on a given topic. The label of the group (Juvenile) was chosen to signify the immaturity of the approach. An existing label from the literature was not chosen because this might imply that there is a complete homology between the science-religion Juvenile stage and an existing description of an early cognitive stage.

The existence of the "Juvenile Free Choice approach" was surmised from the review of the literature on how young children think, together with an analysis of students' descriptions of the approaches they took when they were young children.

In his scheme of cognitive development, Piaget (1952) suggests that children under the age of seven years are unable to make comparisons independently. Goldman (1965) also describes a stage at which young children do not question the information that their parents give them, and do not examine whether new beliefs are compatible with existing beliefs.

All the undergraduate students in this current sample were able to make comparisons independently. During the interviews students described their past approaches to science-religion dilemmas in reasonable detail. In the way of other research projects, analysing this information gave an insight into how children think at an early cognitive stage (see for example Kohlberg & Turiel, 1971; Perry, 1970). Examples of students' comments are:

> "When I was younger, I just accepted the religious beliefs and what the Bible said. Science didn't play a role" (MU5);

> "I studied science at school and I was religious and I just accepted both. Then one day I thought, hang on, is it the evolution theory or the creation theory, what happened?" (MU6);
>
> "I don't think I ever believed. My Mum believes in God but she's not sure enough about it to want to tell us. So we weren't brought up to be religious" (MU7);
>
> "I'm on the atheistic side of agonistism (sic). I was brought up in a very religious family. I was brought up an Anglican and was a member of the church and I just accepted it when I was younger" (MU9).

The comments by 16 of the 20 students indicated that when they were young children, their beliefs on these topics were learnt without question from their parents and other people in authority. Some students indicated that they were only taught the scientific accounts, some the religious account, some neither, some both and some a combined science-religion belief.

The Juvenile Free Choice approach then is one that is taken by students who are not able to compare the accounts.

7.4.3 Free Choice Unconnected Approach

References have already been made to the finding by Goldman (1965) that some secondary school students were unaware until they were interviewed that there were contradictions within their beliefs. Goldman explains that this divided mental frameworks arose because the students had accepted assertions from science and religion independently and had not compared them.

It is interesting to note that most if not all of the secondary-school students in Goldman's study would have had the cognitive ability to compare the scientific and religious accounts. The stage of development at which students can think about the relationships between ideas usually occurs at around the age of seven (Piaget, 1952). The students that

Goldman interviewed had retained a Dualistic perspective because they had not compared the information they had learnt from science and from religion.

This current project looked at the views of undergraduate students. One of the findings from the study was that in some cases a dualistic mental state persists beyond the school years and into the university years.

Within the interviews conducted by Goldman and for this project, students are specifically asked to reflect on dilemmas in which related scientific and religious information is juxtaposed. At this point, it would seem that in many cases, the approach would almost change. In this current project, the existence of this state of mind was mostly surmised from students' comments as they discovered contradictions for the first time. The student MU8 provided a particularly insightful description of her past and current thinking as she identified contradictions in her beliefs for the first time.

In the current sample of 20 students, three students were inferred to have taken Free Choice Unconnected approaches prior to the interview. In these three cases, the categorisation was made on the basis that the students appeared to be unaware of the potential for apparent contradictions when discussing the relationship between science and religion during the opening section of the interview. In two of the three cases, the categorisation was confirmed when the students said later in the interview that they had not considered the issue of contradictions prior to that time. The categorisations for these students were based on both direct comments by students about the general relationship as well as subsequent comments about the novelty of the situation.

It should also be said that in order to have this state of mind, it is necessary to have been raised to believe both scientific and religious assertions, since in Goldman's description of this mental state, the unperceived apparent contradictions are in the mind of the student. If a child learnt science but not religion or vice versa then this compartmentalised state of mind would not follow.

The category is labelled "Unconnected", rather than "Dualism" which is the term used by Goldman (1965) because the term Dualism is also used in the field of cognitive science to

describe the black-and-white view of reality that is held by young children. The compartmentalised mental state that can lead to an individual taking a Free Choice Unconnected approach is one that only arises if an individual has been raised to believe both scientific and religious assertions.

7.4.4 Free Choice Disengaged Approaches

Students who take a "Free Choice Disengaged approach" are those who choose not to compare the information that is available from science and religion. In the typology of Free Choice approaches, there are two categories to describe approaches in which students deliberately disengage from the task of reflecting on the dilemma.

7.4.4.1 Free Choice Disengaged Approach with Fixed Belief

In the current study, several students indicated they did not ordinarily reflect on science-religion issues because they had made a decision about what to believe that rendered the question of apparent contradictions irrelevant in their opinions. This approach was labelled "Free Choice Disengaged Approach with Fixed Belief". The students who took this approach during the interview were individuals who had decided to globally reject either science or religion. An analysis of the responses by these students showed that a global rejection of one or other field can arise gradually through apathy towards science or religion and can also be the result of a conscious decision to reject one source after reflection. A disengaged approach of this kind could also be taken by a student who had not rejected science or religion globally but who saw the issue of contradictions as irrelevant for a particular topic on the basis of a prior belief on that topic.

7.4.4.2 Free Choice Disengaged approach with Undetermined Belief

The "Disengaged approach with undetermined belief" is also an approach in which the individual chooses not to reflect on the information available on science-religion topics, but with this approach, the dilemma is left unresolved. A student might take this approach

if it is felt that an acceptable answer to the dilemma is not available. Quotations from the transcripts that illustrate why students might disengage from reflection in this way were given in Chapter 6.

7.4.5 Free Choice Engaged Approaches

Ten out of the 20 students described Free Choice approaches that involved looking in detail at the assertions made by science and religion on mutual topics with a view to arriving at a belief for each topic. These approaches were grouped in a category entitled "Free Choice Engaged Approach".

7.4.5.1 Seek to Combine

The self-descriptions made by five students (MU5, MU21, MU30, MU32 and MU35) were found to have a similar theme. These students all referred to a desire to combine the information from science and religion. They also indicated that a combined viewpoint is a difficult process and they were not confident of success. The label "Free Choice Engaged: Seek to combine" was used to identify this approach . The comments included:

> "They often clash. I try to adapt them to each other without totally disregarding the other" (MU5);
>
> "They contradict. I try to find links and matches between them" (MU21);
>
> "There's a conflict but they can be made to fit together" (MU32).

The approach appeared to have some similarities with the approach of Assimilation in that it referred to drawing information from both accounts. It was not identical to Assimilation as it is described in the formal academic literature, however, because as these quotations show, these students each described the overall relationship between science and religion as conflicting or contradictory. Many religious scientists including

Berry (1996), Davies (1983) and Houghton (1995a) who take Assimilation-like approaches argue frequently and confidently that there are no real contradictions.

7.4.5.2 Other Approaches in this Category

The analysis of the transcripts indicated that two students MU29 and MU30 who said they choose to think about these kinds of dilemmas, were more confident that harmonious resolutions existed. Their approaches were described as Free Choice Engaged: Can Combine.

Other students who indicted that they had previously engaged in reflecting on these dilemmas described approaches that included favouring science, favouring religion and keeping an open-minded attitude.

7.4.6 Test of Applicability and Results of Analysis

Once the category system was developed, it was tested for applicability by analysing the students' interviews again. It was found that all the responses could be placed into the typology, and all the categories contained at least one entry except for the category for Juvenile approaches. The Juvenile stage is defined here as the stage in which students are not yet sufficiently cognitively advanced to compare the accounts independently. The students in this sample were all deemed to have moved beyond the Juvenile stage. The category was retained in the system on the basis that the aim of the project was to devise a typology that encompassed all the approaches available to individuals at each cognitive stage.

A summary of the results of the analysis of students' Free Choice approaches is given in Table 27 in Chapter 14.2. The findings will be discussed further at that point.

To conclude this section then, the applicability test confirmed that this analysis method has reasonable content validity and offers a meaningful way to describe the approaches taken by students when they encounter a science-religion dilemma in an informal setting.

7.5 Typology of Approaches to the Written Dilemmas

The aim now was to study the sections of the transcripts that contained students' responses to the written dilemma topics and to devise a second typology in the light of the Typology of Free Choice approaches.

The typology of Free Choice approaches was not used as it stood to categorise students' responses to the written dilemmas. The three major differences between the Written Dilemma approaches and the Free Choice approaches were as follows:

- The information about Free Choice approaches was drawn from students' self-descriptions of how they felt prior to the interview. In contrast the students' responses to the written dilemmas were studied directly;

- When students described their Free Choice approaches, they were referring to their general attitude rather than to their response at a specific moment. Contrastingly, students' comments about the Dilemmas indicated their thoughts at that single moment of time;

- The Free Choice approaches were the approaches that students took when they could choose freely whether to engage in reflection on a dilemma. In contrast, in the written dilemma section of the interview, students were asked to seek and discuss apparent contradictions between the paragraphs presented to them.

The two typologies have many similarities. The typology of Free Choice approaches focuses on what is argued to be the first decision that a student makes on encountering a science-religion dilemma, which is whether to engage in reflecting on it. The significance of this decision is apparent when it is observed that about half the students in the sample said that they generally did not reflect on science-religion dilemmas when they encountered them.

An inspection of the transcripts revealed that this course of action was also taken by some students in the written dilemma section, but less frequently. It was decided, on this basis,

to develop a typology of Written Dilemma approaches that focused on the issue of engagement.

In this way the five main categories within the Written Dilemma typology set out five choices regarding engagement that are available to students when they encounter a written dilemma. The existence of these five choices was gleaned from the transcripts. The resulting categories were then refined by inspection to form a logical and arguably complete set.

While the definitions of the Free Choice approaches were loosely worded to encompass students' sometimes-vague self-descriptions of their approaches, the definitions of the Written Dilemma approaches were relatively tight. The questions in the written dilemma section of the interview ensured that all the students addressed the same questions in the same order and as a result, it was possible to define a clear-cut test that could be used to define engagement in a Written Dilemma approach. The selected test and definition of a Written Dilemma Engaged approach was that it was an approach in which the student identified an apparent contradiction or explained why there were no contradictions. The test is appropriate because in the semi-structured interview schedule, students were asked to identify contradictions between the accounts that were presented. This had two effects. Firstly it provided a clear boundary that could used to distinguish the Disengaged approaches from Engaged approaches. Secondly, asking students to identify contradictions encouraged them to take a Written Dilemma Engaged approach even if they ordinarily would choose not to do so.

As with the typology of Free Choice approaches, the aims when developing the typology of Written Dilemma approaches were that it would be logically structured and able to describe the approaches taken by individuals at all cognitive levels. The typology includes categories to describe the approaches that would be taken by young students, and to describe the approaches that would be taken by students who had a compartmentalised or Unconnected mind set. The existence of these approaches was surmised from studies of previous research such as the research by Goldman (1965) and on students' self-

described Free Choice approaches, rather than through the analysis of the written dilemma section of the transcripts.

The five Written Dilemma approaches are:

- Written Dilemma Juvenile approach;
- Written Dilemma Unconnected approach;
- Written Dilemma Disengaged approach with undetermined belief;
- Written Dilemma Disengaged approach with fixed belief;
- Written Dilemma Engaged approach.

When the interviews were analysed in order to categorise students' responses into this typology, it was found to be useful to have a provisional category for what will be called, Transitional comments. These were comments made by some students that indicated that the interview was the first occasion on which they had become aware of the apparent contradictions between science and religion on a given topic. Transitional comments indicated that these students had previously held a compartmentalised mindset.

In the following paragraphs, there are brief comments about each category.

7.5.1 The Written Dilemma Juvenile Approach

A student is said to take a "Written Dilemma Juvenile approach" when the student cannot identify apparent contradictions between the accounts presented in the written dilemma because the student is at an early stage of cognitive development and cannot compare the accounts independently.

This category was surmised to exist largely on the basis of students' descriptions of their earliest approaches to science-religion dilemmas. These comments indicated that when young children encounter a science-religion dilemma, they are unable to compare the

information in the accounts to identify contradictions (see the section on the Juvenile Free Choice category, Chapter 7.4.2).

I had the opportunity to observe this approach informally first hand when I invited my daughter (age 6) to talk about two accounts of how the Universe began. I first read aloud a version of the Biblical account in a children's Bible. I then read aloud a scientific account of the Big Bang in a children's science book. My daughter was then asked, "We've got two things about how the Universe began. What do you think about that?" She replied, "No-one's told me what to think yet."

On a separate occasion, I read the same two passages to my son, aged seven, and asked him the same question. His response was, "It can't be both at the same time. I think the people who wrote theirs second should have read the other one first. Which one was first?" This response indicates that he had concluded that the accounts were exclusive. These responses are particularly interesting given that Piaget (1952) suggests that children are able to make comparisons independently at the age of seven.

7.5.2 Written Dilemma Unconnected Approach

A student is said to take a "Written Dilemma Unconnected approach" when the student is unaware of the apparent contradictions between science and religion on the written dilemma, even though he or she is cognitively capable of comparing the accounts, because the accounts are not placed in attentional juxtaposition.

Given that students were asked to read the paragraphs of scientific and religious information before answering the questions, it seems likely that a student who has passed the Juvenile stage cognitive of development would see the contents of the paragraphs in attentional juxtaposition at this point. For this reason, the chance of students being found to take a Written Dilemma Unconnected approach would seem to be low. This indeed was found to be the case. Three students were judged to have begun the interview with a compartmentalised mindset. Two of these students demonstrated an awareness of apparent contradictions when they discussed the three written dilemmas. One student

gave a confused and apparently self-contradictory reply on one of the dilemmas. On inspection, it seemed that she had not mentally connected the accounts. Her approach was categorised as a Written Dilemma Unconnected approach.

7.5.3 Transitional Comments

Transitional comments are comments made by students who discover for the first time the apparent contradictions between science and religion on a topic that is presented as a written dilemma.

The student MU8 made transitional comments regarding each of the three written dilemmas. This student also stated that the interview was the first time that she had considered the relationship between science and religion in general. Another student, MU34 made transitional comments on encountering one of the three written dilemmas, but indicated a prior awareness of the apparent contradictions within another topic. Goldman (1965) indicated that some students held a compartmentalised view of science and religion. These findings seemed to show that an Unconnected approach does not only follow from a global division of science from religion, but may also follow from a compartmentalised view on one topic that is common to both fields.

7.5.4 Written Dilemma Disengaged Approach

A "Written Dilemma Disengaged approach" is an approach taken by a student who is cognitively capable of comparing the accounts but who declines to take on the task of seeking apparent contradictions in a written dilemma.

Once again, it is notable that the range of students' approaches included approaches that do not appear in the typologies designed for the views of professional scientists and theologians, such as the one produced by Barbour (1988).

Students' self-descriptions of their Free Choice approaches were useful when constructing the descriptions of the Written Dilemma Disengaged approaches. One reason

for this was that in their self-descriptions, students often revealed the reasons why they saw no need to identify contradictions. Secondly, when a student takes a disengaged approach, it is not possible to analyse the decisions that the student makes regarding apparent contradictions since no contradictions are identified. Students' rationales for declining to identify contradictions are the key sources of information about their thinking.

There were two categories of Written Dilemma Disengaged approaches. The first category is Disengaged with undetermined belief and the second is Disengaged with fixed belief.

7.5.5 Written Dilemma Disengaged Approach with Fixed Belief

A "Written Dilemma Disengaged approach with fixed belief" is an approach in which a student chooses not to compare the accounts on a given topic, and instead refers to a global decision to reject science or religion or both in order to conclude what to believe about the topic that is the subject of the written dilemma.

This category covers the situation in which a student declines to seek contradictions within a dilemma because of a prior decision about what to believe about the topic of the dilemma

While several students were deemed to support Free Choice Disengaged approaches with fixed beliefs, only one student, MU4, took a Disengaged approach with fixed belief in the written dilemma section of the interview. The other students identified contradictions between the accounts when asked to do so. From this it was concluded that students who hold fixed beliefs and who generally do not engage in reflection about science-religion dilemmas might agree to identify contradictions when asked to do so.

7.5.6 Written Dilemma Disengaged Approach with Undetermined Belief

The four criteria for the an approach to be labelled "Written Dilemma Disengaged Approach with Undetermined Belief" are that the student:

- Was cognitively capable of comparing the accounts;
- Did not identify an apparent contradiction;
- Did not explain why there were no contradictions;
- Did not indicate a fixed belief.

For a student's approach to be placed in this category, all four criteria were required to be met.

This category was formed to group together the responses made by students who declined to address the issue of apparent contradictions because they were not interested in resolving the dilemmas or because they were resigned to the idea that the dilemmas could not be resolved. The student MU3 made the following comment which clearly illustrated the Disengaged approach with undetermined belief when she studied the written dilemma on how life began:

> "I think a more important question is, does it matter? ... It doesn't matter how we got here and we'll probably never know."

This was a valuable finding from the point of view of confirming that this approach is one that is sometimes taken. It was noted that most of the students who said they generally took an approach of Free Choice Disengaged with undetermined belief prior to the interview, then accepted the task of identifying apparent contradictions in the written dilemma section.

7.5.7 Engaged Approaches

Students are said to take a "Written Dilemma Engaged approach" when they identify one or more apparent contradictions in the written dilemma or explain why there are no contradictions.

This category of Written Dilemma approaches was designed to represent approaches in which students engaged in the task of seeking and discussing apparent contradictions. In the format of this interview schedule, students are asked to identify contradictions once they have read the Dilemma paragraphs. This produced a large number of examples of this type of approach.

The Written Dilemma Engaged approaches were the most complex approaches to analyse and describe. A novel and systematic analysis method was developed and this will be described in a later chapter.

Meanwhile, the conclusion of this section is that using the analysis systems devised thus far, the key information that could be given of each student's approaches to the written dilemma was to say whether they were Juvenile, Unconnected, Disengaged with undetermined belief, Disengaged with fixed belief or Engaged, and whether the student made Transitional comments.

7.6 Analysis Rules

The five categories that were defined to describe students' approaches to the written dilemma topics are Engaged, Disengaged with fixed belief, Disengaged with undetermined belief, Unconnected and Juvenile. Having devised the categories, a set of analysis rules was formulated. The rules arguably show that the categories are discrete, logical and all encompassing. The rules of analysis are:

1) When students identify an apparent contradiction or explain why there are no contradictions, they are taking a Written Dilemma Engaged approach;

2) When students do not identify an apparent contradiction and indicate that they hold fixed beliefs on this topic, they are said to take a Written Dilemma Disengaged approach with fixed belief. Two subcategories in this category are a Disengaged approach that follows a decision to accept science only and an approach that follows a decision to accept religion only;

3) When students do not identify an apparent contradiction and indicate they are not currently seeking an answer to the dilemma, they are taking a Written Dilemma Disengaged approach with undetermined belief;

4) When students indicate that this is the first time that they have considered the dilemma, these comments are categorised as Transitional comments;

5) When students do not compare the accounts (even though it is evident that they are cognitively capable of doing so) then they are taking a Written Dilemma Unconnected approach;

6) When students are judged unable to compare the accounts, they are taking a Written Dilemma Juvenile approach.

7.7 Applicability

To test the analysis method, the students' responses to the written dilemmas were reviewed to discover whether they could successfully be placed into the typology.

On this occasion, the content validity of the method proved to be very good indeed. The responses were distributed unambiguously, due to the clear-cut nature of the analysis rules.

Looking at the non-engaged approaches, one valuable find was the comment made by the student MU4 which fitted the description of the Written Dilemma Disengaged approach

with fixed belief. In this approach, the student bypasses the question of apparent contradictions and moves directly to a statement about a belief. When asked to identify any contradictions between the paragraphs on the topic of prayer, this student replied, "I don't believe prayers can be answered because I don't believe in a powerful God" (MU4).

In her interview, the student MU3 provided evidence that the Written Dilemma Disengaged approach with undetermined belief is also a justifiable member of the set. Given that students were asked to find contradictions, it was fortunate from the point of view of testing the category system that these students declined to follow this request and hence provided examples of Written Dilemma Disengaged approaches with fixed beliefs and Written Dilemma Disengaged approaches with undetermined beliefs. A prediction that these approaches might exist was largely based on the typology of Free Choice approaches (see Section 7.5.5).

The results of the analysis are given in the section of this thesis that focuses on results (see Chapter 13). To conclude this section it can be said that the proposed typology of Written Dilemma approaches was used to place the students' responses into appropriate categories was straightforward with no questionable categorisations.

7.8 Chapter Conclusion

In the work described in this chapter, students' self-descriptions of their attitudes towards science and religion were studied. On the basis of these findings, a typology of Free Choice approaches was produced to describe how students said they generally responded when they encountered a science-religion dilemma. Work then began on a second typology to describe students' approaches to the written dilemmas presented in the interviews.

On studying the transcripts, it emerged that the first question when analysing a student's approach to a written dilemma should be to ascertain whether the student engaged in the task of identifying contradictions. The typology constructed in this chapter focuses on

setting out the options that are available when the decision about whether to engage in such reflection is made (see Figure 4).

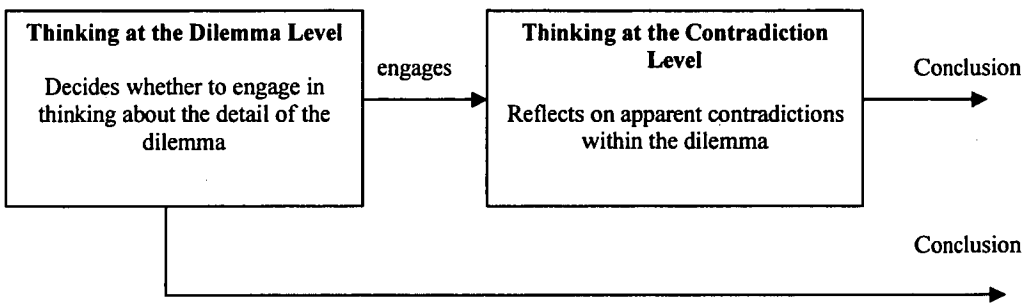

Figure 4. The two main types of decision-making in a Dilemma approach.

The five categories of approaches to the written dilemmas are:

- Written Dilemma Juvenile approach: The individual is cognitively unable to compare the accounts and so unable to identify contradictions;
- Written Dilemma Unconnected approach: The individual does not hold the accounts in single attentional focus and so does not identify contradictions;
- Written Dilemma Disengaged approach with undetermined belief: the individual is disengaged from the task of identifying contradictions and does not have a resolution for the dilemma as a whole;
- Written Dilemma Disengaged approach with fixed belief: The individual is disengaged from the task of identifying contradictions because of a decision to globally reject science or religion or both;
- Written Dilemma Engaged approach: The student engages in the task of comparing the accounts and identifies one or more apparent contradictions.

In the cases of the non-engaged approaches, the definitions of the categories seemed to provide meaningful descriptions of how the student responded to the issue of apparent

contradictions. In regard to the Written Dilemma Engaged approach, it was surmised that additional analysis methods would reveal more about the thinking that students engaged in when they took this approach.

In the chapters ahead, descriptions are given of analysis methods that looked at students' thinking on these issues.

CHAPTER 8

THE WRITTEN DILEMMA APPROACH MODEL

8.1 Introduction

The analysis method described in this chapter continues the work described in Chapter 7 regarding how to analyse students' responses to the written dilemmas.

The written dilemma section of the interviews contains information about how students think about apparent contradictions. As explained in Chapter 7, analysis of the transcripts showed that when students are presented with a dilemma, they may not engage in thinking about the apparent contradictions. Students' tendency to choose approaches that avoid the issue of contradictions was also noted by Schneller (1982). This means that when students describe their beliefs it is not certain how they arrived at those beliefs and whether or not they have considered the issues raised by the apparent contradictions.

In the written dilemma section of the interview students were specifically asked to identify and discuss apparent contradictions. Most students engaged in this task, even if this was something that they said they generally did not do on encountering a science-religion dilemma.

The interview questions ensured that all students addressed the same questions, beginning with the question of what contradictions they perceived to exist. The order of the questions meant that it was possible to map a sequence of reflective steps and decisions that the students made on the way to describing a final belief. Once a first draft of the Written Dilemma approach model had been drawn up, the sequences of steps within the model provided a visual way for the information contained in the transcripts to be categorised and coded.

This mapping process was a useful aid on the way to explaining why students arrived at individual decisions. Further rounds of analysis to discover the thinking that led to students' decisions will be explained in subsequent chapters.

8.2 The Layout of the Written Dilemma Approach Model

The Written Dilemma approach model sets out a series of key decisions and reflective steps that students are surmised to face once they encounter a written dilemma. These steps are arranged on a line that is initially vertical.

The nature of the steps and the options available to students emerged during the analysis of the transcripts. Many of the steps were suggested by the nature and order of the questions in the interview, which probably also influenced the order and nature of students' thinking. One such key decision was described in Chapter 7 and is the question of whether to engage in identifying apparent contradictions. Several outcomes for this decision were outlined. Each outcome corresponds to a different approach. Some students engage in identifying apparent contradictions. This approach is represented by a vertical line in the model. The other outcomes of the decision about whether to engage in identifying contradictions are shown as lines that branch from the main vertical line in the model.

8.3 Early Draft of the Written Dilemma Approach Model

Figure 5 shows the Written Dilemma approach model in a preliminary form. Later in the project, two rounds of minor revisions were made. The first round of revisions was made to show how the approaches available to an individual depend on the cognitive stage of the individual according to the conceptual sequence. The second round of revisions was the addition of more detail to the sequence of steps described for the Engaged approaches. These revisions are shown in the final model; which is presented in Chapter 11.

Figure 5 also indicates the apparently discrete and all-encompassing nature of the five main categories.

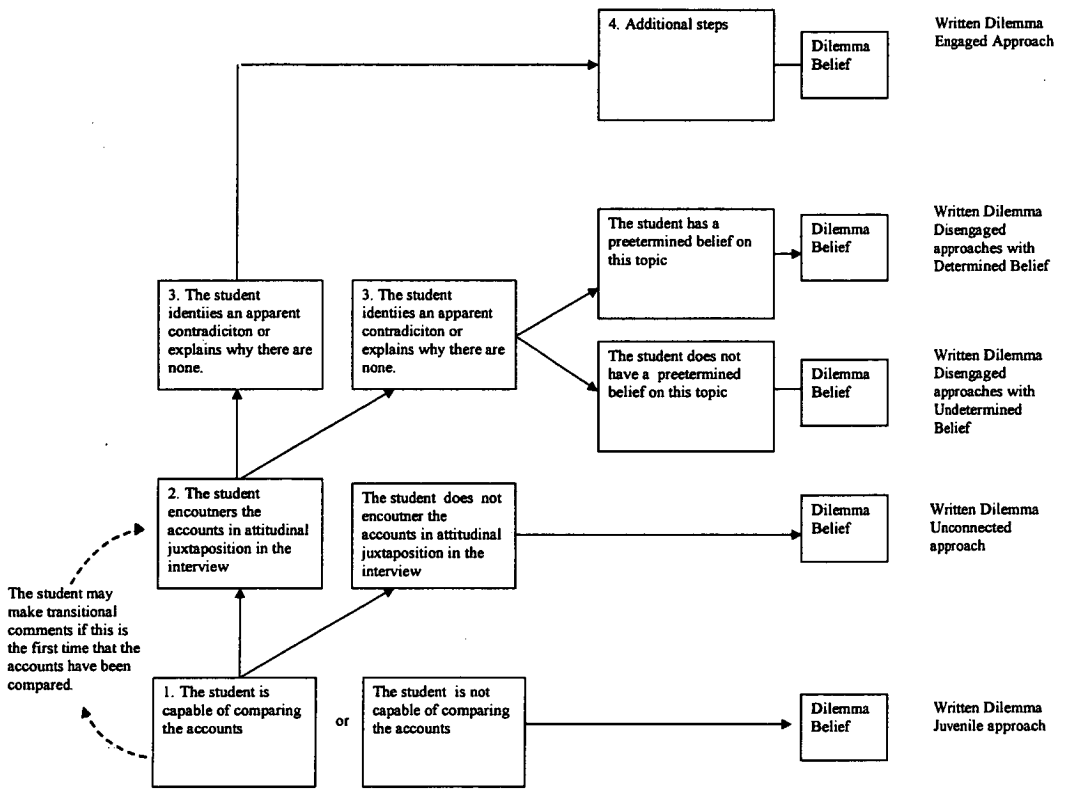

Figure 5. An early version of the Written Dilemma approach model.

8.4 Written Dilemma Approaches Without Engagement

There are four Written Dilemma approaches in which the individual does not engage in the task of identifying apparent contradictions in a dilemma:

- The Juvenile approach is taken by students who are cognitively incapable of comparing the accounts;
- The Unconnected approach is taken by students who do not hold the two accounts in attitudinal juxtaposition (a situation that is unlikely in the interview, given that the dilemmas are presented to the students),

- The Disengaged approach with fixed belief and the Disengaged approach with undetermined belief. In these cases, students deliberately decline to engage in the task of identifying apparent contradictions.

These descriptions of Disengaged approaches are meaningful ways to describe the thinking that underlies a number of the responses that individuals may give they encounter a science-religion dilemma. The descriptions of the approaches consist of the key decisions that are made and an explanation of why those decisions are made. For example, a student who takes the approach entitled "Disengaged with fixed belief – science" is someone who chooses not to engage in identifying contradictions having made a prior decision to reject the religious account entirely. Further insight into this individual's approach can be given by saying whether the student rejected the religious account through apathy or after consideration.

8.5 The Written Dilemma Engaged Approach

The Engaged approaches were of particular interest in the study because it was surmised that some students taking these approaches were operating with relatively complicated rules as they made their decisions. The kinds of thinking that I predicted might be taking place included interpreting the passages, identifying perceived contradictions and evaluating the validity of opposing claims.

In contrast, when students take a Disengaged approach, they move directly to a particular belief. The method used to analyse students' Engaged approaches is described below. One section of this method was later revised on finding that it could not resolve the students' ambiguous use of the terms "science" and "religion". In the section below the successful and unsuccessful analysis methods are described, together with an explanation of the issue of ambiguity. Chapter 13 presents the results of the final analysis system.

8.5.1 Devising a Method of Analysis for the Engaged Approaches

In the Written Dilemma approach model, the steps in the Engaged approach display the major decisions that a student is said to make when studying a science-religion dilemma. The purpose of studying students' decisions was to find occasions when a student's decision at a particular step could be connected with other characteristics of the student's views in order to construct explanations of why students responded as they did.

Writing out a sequence of steps in the model was relatively easy. In the first version of the model, the steps in the sequence were based on the questions in the interview. The first two steps were:

- Identify the contradiction;
- State whether the contradiction is real or apparent-only.

When the model was used as a way to analyse the transcripts, however, it was found that analysing the decisions that students made when taking Engaged approaches was challenging. The difficulty was that devising an objective system to code students' decisions was not straightforward. The reason for the difficulty was that each student frequently used the terms "science" and "religion" to describe his or her views. It was suspected, however, that the idea of what is science and what is religion might change from one student to the next. Thus if two students said, "I take the science view", then their decisions might not be equivalent even though they made the same comment.

In a broad way, there are many views of science and religion and in another kind of research project, small differences of understanding in a sample of students might not be an issue. For this research, however, there are particular areas of contention that are crucial in determining an individual's view of the relationship between science and religion. It was explained in the literature review that the widely perceived contradictions between science and religion are said by some authors to arise when assertions that are not authentically scientific or religious are brought together. In this thesis, the term

"apparent contradiction" is used rather than "contradiction" to acknowledge that the authenticity of contradictions is not universally agreed.

In a similar way, it seemed possible that one group of students might say that they support science and be referring to a view of science that permits divine creation, while another group of students says that they support science and be referring to a view of science that equates to materialism.

The subjective use of the terms "science" and "religion" was relevant when analysing almost every decision in the sequence. Resolving this issue was a major challenge in the research. In this chapter, the steps are displayed but the analysis rules for some of the steps are given later in the thesis. After the model was tested, a minor change was made to one of steps. The steps in the first version of the model are shown in Figure 6:

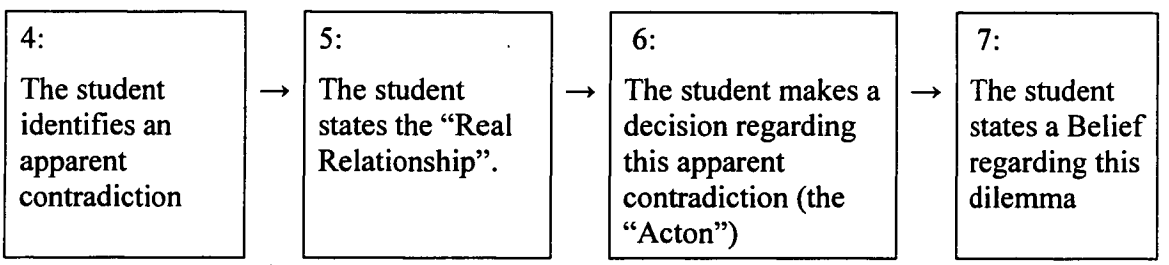

Figure 6. Steps 4-7 in an Engaged approach (version 1)

8.5.1.1 The Apparent Contradiction

The challenge of how to describe students' descriptions of apparent contradictions objectively is described in Chapter 9 and the analysis codes are given in Chapter 10.4.1.

8.5.1.2 The Real Relationship

The next step in the analysis was to describe the student's view of the "Real Relationship" for each apparent contradiction. The categories for the Real Relationship were:

- Real contradiction (refers to one view only);
- Real contradiction (refers to multiple views);
- Compatible (refers to one view only);
- Apparent-only (refers to multiple views).

The descriptions of the real relationship indicate whether the student referred to other perspectives on the issue. The question of whether the student is aware that other views exist will be shown to be an important question in this research. Analysis of the transcripts showed that some students were aware of other perspectives but most were not. Prior to the analysis it was assumed that students who explained why science and religion do not contradict within a given dilemma would be aware of other views that do lead to the perception of a contradiction. When analysing the interviews, however, it was found that some students identified points of compatibility but did not indicate that any other view might be held. To accommodate the range of responses that students gave and could theoretically give, the four categories were devised.

8.5.1.3 The Action

The "action" was an invented term to describe the decision that the student made about which assertions to accept and which to reject. The types of comments that were analysed to discover the action were: "I take the scientific view".

The ambiguity of the terms "science" and "religion" meant that it was not possible to describe students' actions objectively until a way to analyse apparent contradictions had been devised.

In the meantime, a study was made within each student's interview of the student's actions regarding the three dilemmas to test for consistency. This showed that some students consistently rejected (or accepted) the religious (or scientific) account, while others changed their action from topic to topic. What was not revealed, however, was

whether the variability of some students' actions was due to a consistent but complicated approach, or whether it was the result of inconsistent thinking.

One of the findings from the literature review was that sophisticated approaches such as Assimilation lead individuals to respond in a complex way to the task of accepting and rejecting alleged assertions from science and religion. The action taken by an Assimilationist would include accepting an alleged religious assertion of divine creation, but rejecting some alleged assertions of Biblical data.

The question arose, were some students taking the approach of Assimilation when they took actions that were apparently inconsistent for the three topics. On the basis of the information available thus far, this question could not be answered.

8.5.1.4 A Study of Students' Rationales

Students' rationales for their decisions were then studied in an attempt to discover the reasoning that led students to their decisions. Students gave rationales when they gave their final decision about what to believe regarding a contradiction. Quotations were drawn from the transcripts and were marked to indicate whether they were stated as generalisations or were said in the context of a particular topic. An example of a generalisation is: "I'm an evidence girl" (MU7). An example of a topic-specific rationale is: "I've seen a lot of evidence for the scientific version and not much for the religious viewpoint" (MU7). The results of this analysis are presented in Chapter 14.5. The findings gave an insight into how students decide what to believe once they perceive a contradiction, but were less helpful in terms of explaining why so many students saw science and religion as contradictory to begin with.

8.5.1.5 The Belief

The interview schedule dictated that students should be asked to describe their beliefs about each dilemma whether or not they had identified apparent contradictions between the written paragraphs.

Students' statements about their beliefs were often intermingled with "action" type statements in the transcripts but were compiled separately. Beliefs were expressed in such terms as: "I believe life began by chance". A belief-type statement does not contain the words science or religion. A method of objectively describing students' beliefs was devised with relative ease. The issue which was addressed was ensuring that the terms "science" and "religion" were defined where they were used in the coding. The categories that were defined to describe students' beliefs were:

- Science only;
- Religion only;
- Combined (A belief that draws on science and religion);
- Neither (Neither science nor religion);
- Undecided.

The rules of analysis for students' beliefs that accompanied this system were:

- Science-only: the student accepts information from the scientific account only, and no information from the religious account. (In this case the beliefs are those that would be held by a scientific materialist, but the student does not necessarily support this view of the nature of science);
- Religion only: the student accepts information from the religious account only, and no information from the scientific account. (In this case the beliefs are those that would be held by a Biblical literalist, but the student does not necessarily support this view of the nature of religion);
- Combined: the student draws information from both the religious and the scientific paragraphs;
- Neither: the students' beliefs are not based on science or religion;

- Undecided: the student has not formed a belief on this topic.

When devising labels for students' beliefs, the terms "materialism" and "fundamentalist" were avoided because they imply that an individual supports a particular view of science or religion. In this thesis, I argue it is important to bear in mind that beliefs can be formed with and without examination. Young children may learn beliefs from their parents without knowing what view of science or religion they originally came from. Thus if the analysis finds that a student's beliefs come from science only, it is not true to say that this student actively selects science as the only source of truth. Later an analysis system will be developed that infers students' views of science and religion and these inferred views will be described using terms such as "scientific materialism". This analysis of students' beliefs provided a number of valuable findings which will be presented in Chapter 13.5.

An ability to describe student' beliefs however does not lead directly to an understanding of how students arrived at those beliefs, which is of more interest in this project. As a result, if students arrived at different types of beliefs for different dilemmas, which transpired to be the case for 11 of the 20 students, it could not be said whether these students were thinking about the dilemmas with a set of consistent but complex rules, or whether these different conclusions were a result of inconsistent and possibly cognitively immature thinking.

8.6 Chapter Conclusion

The Written Dilemma approach model emerged when the key decisions that students made on encountering a dilemma were analysed. The model was devised to place the students' approaches into categories where all the approaches in each category involved a common sequence of decision-making steps.

It was intended that once completed the model would also provide a way to describe the characteristics of similar approaches and to give meaningful descriptions of individuals' approaches.

The major categories of approaches are displayed as lines of thinking branching from a central line. The central line shows the decisions that are made during an Engaged approach, which is an approach in which contradictions are identified. The other categories are represented by showing the step or decision at which the individual moves away from the engaged sequence of decisions.

The lines for the Non-Engaged approaches contained only a few steps each. Furthermore, in the cases of these approaches, the relevant decisions were known via analysis and the reasons for making them were also known. The Written Dilemma approach model together with the methods of analysis described to this point seemed to offer meaningful descriptions of the non-Engaged approaches.

For the Engaged approaches, there were comparatively more decision-making steps on the timeline. Work began to analyse these decisions and to attempt to connect the outcomes to other characteristics of each student's thinking. The problem of ambiguous terminology was encountered which made this process difficult.

It was concluded that to probe students' reasoning further, it would be useful to develop:

- An objective way to describe the apparent contradictions that students identified;
- A way to connect the outcomes of students' decisions at as many steps as possible with other characteristics of their views and thinking.

The construction of additional analysis methods to address these needs is described in Chapters 9-12. Chapters 13 and 14 present the findings that were obtained when the final analysis system was applied to the interview transcripts.

CHAPTER 9

THE DEVELOPMENT OF TWO ADDITIONAL METHODS OF ANALYSIS

9.1 Introduction

Chapters 9-11 describe the development of two original methods of analysis which are named "the Contradiction-type analysis method" and the "Conceptual Cognitive Sequence analysis method". In Chapter 12 the major analysis methods described in Chapters 7-12 will be drawn together to produce the finished "Written Dilemma Analysis system". It will be shown that this analysis system can be used to provide a meaningful description of an individual's approach to a science-religion dilemma. The rounds of analysis within the Written Dilemma Analysis system are designed to find out:

- The Basic Approach category;
- The student's position in the cognitive sequence which was found using the Conceptual Cognitive Sequence analysis method;
- The students' inferred views of science and religion (via the contradiction-type method of analysis) and the details of the apparent contradiction(s) that the student identifies;
- The student's belief on this dilemma.

9.2 The Need for Further Analysis

In Chapters 7 and 8 a method of analysis was presented which defined five basic categories of approaches and which set out the steps of decision-making involved in each category of approach. It was explained that as it stood, this step-by-step analysis method had two limitations. Firstly, it did not include an objective way to describe the apparent

contradictions that students identified. Secondly, it did not reveal the thinking that underlay students' decisions when they took an Engaged approach.

As stated at the conclusion of the previous chapter, the direction of the research from this point was to:

- Devise a way to describe apparent contradictions objectively;
- Find meaningful connections to explain students' decisions in terms of other characteristics of their thinking.

9.3 The Development of the Additional Analysis Methods

Section 9.3 presents an overview of the stages of research that eventuated in the contradiction-type analysis method and Conceptual Cognitive Sequence analysis method.

In the review of the literature presented in Chapter 2, many references were made to the argument that the contradictions that people perceive can be explained by referring to the views of science and religion that they hold.

This observation led to a premise that there is a relationship between the views of science and religion that an individual holds and the types of contradictions that the individual perceives.

In presenting this premise, it was noted that it was based on the descriptions of the relationship between science and religion that are presented in the formal academic literature. These refer to the considered views of academic experts recently and historically. Even if it is shown to be true in the case of these experts' views, my research will need to show whether this premise is true for students' views of science and religion and their perception of contradictions.

With this point noted, the first method used to examine the strength of the premise was to study a selection of views of science and religion drawn from the academic literature.

These views are referred to as "Standard views". It was found that it was indeed possible to link pairs of views of science and religion with the perception of particular contradictions. A table was produced showing these connections. Table 12, is presented in Section 10.2.8.

The next part of the research sought to connect students' views of science and religion with their perceptions of contradictions. Students' views of science and religion were drawn from the parts of the transcripts in which students addressed the questions: "What is science?" and "What is religion?" Their responses to these questions were found to be too imprecise and lacking in detail to provide the kind of information that was sought.

This line of inquiry was almost abandoned at this point. Then a more detailed analysis of the contradictions that students identified revealed many clear references to the types of contradictions discussed in the literature and described in Table 12.

A change of direction was made. The original aim was to look at students' descriptions of science and religion and to attempt to predict the types of contradictions they would perceive. In the new methodology, the contradictions that students identified were used as a starting point, and an analysis system was devised that inferred students' views about science and religion from the contradictions that students identified.

To assess the validity of these inferences, a number of tests were devised. For example, the consistency of students' inferred views was assessed on a dilemma-by-dilemma basis.

The findings from these tests provided information about students' views of science and religion, and also about the depth of their thinking. As might be predicted, students' views were found to be less coherent and detailed than the expert views.

These findings were placed into the context of a conceptual sequence of cognitive development for this area of thinking. This conceptual sequence explains why for some people, the perception of contradictions depends on their views of science and religion, while for others, the link is less robust.

Finally an analysis method was developed that can provide useful information about students' reasoning about contradictions. On the basis of the preceding work, this analysis system was designed to probe the rules that students operate with, and also the consistency with which they apply those rules. This information was presented in the context of the Written Dilemma approach model to explain some of the decisions that individuals make when they take an Engaged approach.

9.4 The Remainder of this Chapter

The analysis methods referred to in this chapter build on two original lines of inquiry. One line of inquiry seeks an explanation of how an individual's views of the natures of science and religion may produce a perception of particular types of contradictions. The other line of inquiry seeks to describe how individuals at different stages of cognitive development differ in the ways in which they approach science-religion dilemmas.

The two areas of research will be presented separately and will then be drawn together. Sections 9.5 and 9.6 in this chapter describe the development of a conceptual sequence to describe the cognitive development that takes place in this kind of thinking. Chapter 10 describes a way to find individuals' views of science and religion from the contradictions that they perceive.

9.5 A Conceptual Sequence of Cognitive Development for this area of Thinking

9.5.1 The Natures of Science, Religion and Reality

This section presents a novel description of the differences between the approaches taken by those who are relatively inexperienced in thinking about these dilemmas and those at what will be called the Expert-philosophical stage. The lack of a theory describing how individuals advance in this kind of thinking was indicated by Gardner (1999).

Following the recommendation by Reich (1998), the starting point in this description is the set of skills and understandings that are argued to underlie the approaches taken by those at the most advanced stage.

When developing the conceptual sequence of cognitive development it was found that analysing the responses by individuals to the science-religion dilemmas was made simpler by referring to three "natures". These three natures are the nature of science, the nature of religion and the nature of reality. This novel method of describing the views that individuals hold will be used to explain how an individual can see science and religion as conflicting and yet maintain that both fields have some truth.

9.5.2 The Expert-Philosophical Stage

In the cases of those who take the most advanced approaches to science-religion dilemmas, I argue that their views of science and religion are not assumed, but are considered. The views that are held as a result of this process of examination vary from person to person.

Some individuals take a post-modern perspective and conclude that reality is unknowable. The philosophers Derrida and de Mann are examples of individuals who hold this view (de Mann, 1986; Derrida, 1978).

Others, including Barbour (1988), Berry (1996), Easterbrook (1999) and Houghton (1995b), reflect on the natures of science and religion with the confidence that a harmonious view of the relationship between them is an achievable prospect, and that reality can largely be described by drawing on these fields of explanation.

While drawing their own views, these individuals are aware that other views also exist. Thus in "Ways of Relating Science and Religion" (Barbour, 1988), it is evident from the first paragraph that the paper will look at the nature of science and the nature of religion, and the different understandings of each that may be held. Barbour begins his argument by stating that people hold different views about the nature of science and of religion, and

then shows how these different viewpoints lead to different views about the relationship between science and religion.

Thus it is my argument that Barbour's widely-cited typology of conflict, independence, dialogue and integration demonstrates his awareness of multiple views of science and multiple views of religion and his ability to describe the different relationships that these views combine to produce.

This claim that advanced thinkers form views that are more organised, consistent, detailed and conscious than the views of laypeople is compatible with widely accepted descriptions of adult thinking (Basseches, 1984; Langford, 1995; Perry, 1970).

To describe his own view of science, Barbour uses the term "critical realism" (1966, p. 43). In his description of his reflections on this matter, Barbour explains that his view differs from classical realism and also from instrumentalism in which scientific theories are regarded as calculative devices. Instead, in his view, scientific models "are to be taken seriously but not literally" (1966, p. 43). Barbour explains that it is possible to make a similar case for critical realism in theology, saying that theological concepts are also subject to continual revision.

In the paragraphs below, I describe another common feature of the views advocated by the religious scientists.

9.5.3 Approaches in the Academic Literature

Twenty books and papers by respected authors in this field were examined (see Appendix L). On the basis of this examination, it was surmised that the approach of Assimilation, which is an approach that many of the selected authors advocate, satisfies three criteria:

- The Assimilationists are aware of multiple views of science and religion;
- Both science and religion are considered valuable sources of information (and so neither is globally rejected);

- The assertions made by "real science" and "real religion" are said to combine to form a self-consistent view of reality.

The terms "real science" and "real religion" in the third point refer to the religious scientist's own views of science and religion respectively. The Assimilationist insists that "real science" and "real religion" are compatible and so looks for views of science and of religion that can be combined to produce a self-consistent set of principles of reality.

To illustrate this using an example from literature, consider the apparent contradiction between the evolution of humans from a prior species and the Biblical description of the miraculous, instantaneous creation of Adam and Eve. In Chapter 2.5.4.2, it was stated that Berry, a biologist who supports the approach of Assimilation, addresses the dilemma of how human life began in the following way:

> Clearly he (God) could have made Eve from one of Adam's ribs, but that does not mean that he actually did so ... It is fully consonant with Genesis that God created Adam in the body of a Near Eastern farmer comparatively recently in archaeological terms
>
> (Berry, 1996, p. 50).

On the issue of whether it is scientifically acceptable to believe that God intervened in this way, Berry holds that "it is entirely reasonable to believe in a supernatural God" (1996, p. 110). This reasoning follows from Berry's view that science does not object to the possibility of divine action, since "science deals with the mechanisms by which evolution occurred, which are not described in the Bible" (p. 117).

Thus in his response to this apparent contradiction between science and religion, Berry reformulates the description of events given in the Bible to fit with mainstream science, and combines this with discrete theistic action, which he sees as compatible with science.

Berry's approach is Assimilation and he believes that the principles of science are compatible with the principles of religion. This is Berry's description of his approach:

> It is wholly consistent with both science and Scripture to insist that God is the Creator, but also that he worked through mechanisms which we may discover through scientific research (1996, p. 44).

If another scientist reflected on this proposed solution with view to adopting it also, he or she might consider the following questions:

- Is the Bible intended to be read literally or allegorically? (Nature of religion)
- Does God influence events in this Universe? (Nature of reality)
- Does science oppose the possibility of a miracle? Does science oppose discrete theistic action? (Nature of science)

In making decisions about each of these questions, the individual examines the principles that define the natures of science, religion and reality. The principles that underlie these views of science and religion and reality are:

- Science does not oppose the possibility of discrete theistic action (Nature of science);
- Biblical assertions about events and data are not always intended to be read literally. They can be reformulated when they are contradicted by assertions from mainstream physical science (Nature of Religion);
- Religion asserts that discrete theistic action guides the fate of our Universe (Nature of Religion);
- Reality can be described in terms of physical science combined with discrete theistic action (Nature of Reality).

A second issue that is frequently raised is the question of whether divine action necessarily violates our current understandings of the physical operation of the universe. Many religious scientists see a way for God to achieve his will without breaking scientific

laws through quantum chance. In Polkinghorne's view, for example, "the role of chance can be seen as a signal of the Creator's allowing his Creation to make itself" (1996, p. 47).

If it can be accepted that divine action can take place without violating the current scientific descriptions of the workings of the universe, these scientists argue that science does not oppose the possibility of divine creation and even ongoing divine guidance. On this basis, Barbour (1988), Peacocke (1990), Berry (1996), Davies (1983), Haught (1995), Houghton (1995b), Penrose (1989), Pilkington (1960), Polkinghorne (1996) and Russell (1988) all describe the natures of science and of religion as compatible, thus supporting their claims that science and religion both have validity.

The details of science and religion vary from individual to individual in this group. In all cases, they are "reformulated" versions of the traditional forms but the details of the reformulations vary. This point will be raised again later in this section when I present a more systematic way of describing the different views. In this section, an overview will be given in order to present evidence that the possibility of changing science and religion from their traditional forms is indeed something the most advanced thinkers are aware of.

9.5.4 The Conflict View

In contrast with the views described above, there are some views of science and religion that lead to a conflict-view of the relationship. One cause of a conflict-view is if an individual holds that the nature of science is Scientific Materialism.

Consider, for example, the views of Dawkins, the much-publicised academic and atheist. While others debate whether there is literal or allegorical truth in Biblical texts; Dawkins rejects the notion that any claim should be believed, unless there is supporting evidence for it. In other words, Dawkins only accepts assertions that are supported by science. This is in contrast with the approach of the religious scientists who may accept the validity of religious assertions, provided science does not oppose them. This quotation illustrates Dawkins' view:

> But what, after all, is faith? It is a state of mind that leads people to believe something - it doesn't matter what - in the total absence of supporting evidence. If there were good supporting evidence then faith would be superfluous, for the evidence would compel us to believe it anyway.
>
> (Dawkins, 1989, p. 198)

Dawkins' view of science as Scientific Materialism is one that supports his view that science and religion contradict irreconcilably. His view of reality is compatible with his views of science and religion, since he believes that nature can be perfectly described using physical explanations alone.

In some cases, it is an individual's view of the nature of religion that leads to a view of conflict. Barbour states that both Biblical Literalism and Scientific Materialism lead to a perception of conflict:

> Scientific Materialism is at the opposite end of the theological spectrum from biblical literalism. But they share several characteristics which lead me to discuss them together. Both believe that there are serious conflicts between contemporary science and traditional religious beliefs.
>
> (Barbour, 1988, p. 21)

Thus according to Barbour (1988) there is conflict between science and religion in the minds of supporters of Biblical Literalism and also in the minds of supporters of Scientific Materialism. I argue that although Barbour does not say so explicitly, it is not necessary to hold *both* of these extreme views to perceive a conflict between science and religion. Biblical Literalism with any of several views of science produces conflict as does Scientific Materialism combined with any of several views of religion.

The situation of the Creationists should also be mentioned at this point. Creationists are Biblical Literalists who perceive a conflict between religion and mainstream science but who argue for an alternative version of science which is compatible with their religious beliefs. In this view, mainstream science is reformulated to produce what the Creationists

regard as the corrected view of the nature of science. As such Creationists argue that they have a rational and coherent view of reality that combines Creation Science with Biblical Literalism.

Contrastingly, there are other supporters of Biblical Literalism who choose to reject science totally. Their view could be said to combine Anti-science and Biblical Literalism. In this way, these individuals also resolve the apparent contradictions and arrive at what they claim to be a coherent view of reality.

It should be said that an individual's view of the nature of religion would probably include many more principles than simply whether the individual believes religion requires a literal reading of Bible texts. Similarly a philosophy of science would probably include more than whether science is seen as Scientific Materialism. The only aspects of these philosophies that are presented here, however, are those that are relevant to discussions about the interaction between science and religion.

Additionally, there are likely to be individual, minor differences between a number of approaches that in this conceptual sequence would be given a common label. For example, the approach of Assimilation as it is described here involves the reformulation of religion when it is contradicted by the assertions of mainstream science. This description was drawn from Barbour's description of his own approach (Barbour, 1988). The decision as to whether an alleged scientific assertion was sufficiently part of the mainstream to warrant this action would in all likelihood vary from person to person.

That said, I argue that in broad terms, there is a range of academic expert approaches advocated in the literature, in which the apparent contradictions are resolved, either by rejecting science or religion totally (as per the responses by the Materialists and Anti-scientists) or by holding compatible views of science and religion. Further examples from the views of academic experts were given in Chapter 2.5.4.2.

9.5.5 The Aim of Forming Self-Consistent Views

Based on these readings, it seems that a goal for the scientists described above is to form a set of self-consistent principles with which to judge the world. (Another approach would be to take a post-modernist perspective but here I will focus on the approaches described in the academic literature on science and religion.) I argue that forming a set of principles that are self-consistent and acceptable to the individual can be a challenging task. Highly reflective thinkers assess multiple views of science and multiple views of religion, while also reflecting on the implications of combining these views.

The results from this reflection may not be the view of science and/or religion and/or reality that the individual would most like to have and compromises may need to be made in one field in order to accommodate principles in the other. Davies explains that his reflections on the relationship between science and religion have led him to discard many traditional, but in his view, untenable, religious concepts including the idea of a loving, personal God (Davies, 1995).

To conclude, then, I propose that at the most advanced cognitive stage in this area of thinking, individuals are aware that the natures of science and religion are not universally agreed, and reflect on different possibilities. I also argue that within this group, the religious scientists who support Assimilation operate with the additional requirement that science and religion are compatible.

9.6 Relating Students' Responses to the Conceptual Sequence

The students in the sample were judged to be at a lower stage of cognitive development than the Expert-Philosophical stage according to this conceptual sequence on the basis that they did not appear to have critically examined the natures of science and religion. Many of the students were judged to be at the preceding stage, described below.

Prior to the Expert-Philosophical stage, there is a stage at which individuals have established consistent beliefs about the natures of science and religion, but have not

critically examined those beliefs. This stage is called here, the Unexamined Principled Stage. At this stage, the individual's ideas about science, religion and reality were formed through everyday experience and education. It has been reported elsewhere that students form unstructured collections of ideas naturally and unless challenged, may not examine their beliefs (Richardson, 1997).

The characteristics of the Unexamined Principled Stage are twofold. The first characteristic is that the individual has not examined the natures of science and religion. The second characteristic is that the individual's views of the natures of science and religion are reasonably detailed and consistent.

The second characteristic is an important one. A students who holds consistent views of science and religion regarding the principle of concern here, would according to the preceding theory, perceive consistent types of contradictions.

9.6.1 The Narrative Stage

Prior to both the Expert-Philosophical Stage and the Unexamined Principled Stage, I propose, there is a still earlier stage which is called here the Narrative Stage. At this stage, the individual has not formed fixed and consistent views about the natures of science and religion. At this stage, the student's views are unexamined, are less well defined, and may be inconsistent.

9.6.2 The Juvenile Stage

The earliest stage in this conceptual sequence of cognitive development is the Juvenile Stage. At this stage, individuals do not question the beliefs that they are taught and in do not examine their beliefs for self-consistency.

According to Piaget's theory of cognitive development, a child becomes capable of independently making comparisons at the age of approximately seven years. At this stage children have completed a year or two of school and are likely to be aware that there are

many sources of information that occasionally present different views of the world. If children at this stage encounter the scientific and religious accounts at the same time, they can compare them and identify that there are differences between them. An ability to identify apparent contradictions marks the second stage in the sequence.

9.6.3 Summary of Stages

The four stages in the conceptual sequence devised in this research are:

- The Expert-Philosophical stage;
- The Unexamined Principled Stage;
- The Narrative Stage;
- The Juvenile Stage.

A feature of this progression is that it does not identify one belief as more intellectually advanced than another. What matters is the way in which the belief is formed. The progression also does not imply that one view of the nature of science/religion is more advanced than another. Importance is placed instead on whether individuals have considered alternatives, or whether they learnt their beliefs without question.

9.7 An Analysis Process to Locate Students' Approaches within the Conceptual Sequence

To produce a simpler analysis procedure to locate students' approaches to the dilemmas within the devised conceptual sequence, a set of skills and understandings associated with each stage was constructed. This was used to produce descriptions of how students might reveal that they had acquired the skills associated with a given stage as they addressed the written dilemmas.

9.7.1.1 Identifying Thinking at Stage 1

Individuals reveal that they are at stage 1 within the conceptual sequence if it is evident that they cannot compare the information in the two paragraphs without guidance.

9.7.1.2 Stage 2 and Above

Three criteria were used to identify thinking at stage 2:

- Students reveal they are at stage 2 or higher when they identify apparent contradictions between the accounts or explain why there are no contradictions;
- When students are inconsistent on issues such as whether science opposes divine creation, this indicates thinking at stage 2;
- When students identify contradictions in the dilemmas in a way that is terse or wordy, indicating an apparent lack of understanding of the issues involved, this indicates thinking at stage 2. In contrast, students who identify the causes of contradictions and seem more skilled at thinking about these problems are said to be at stage 3.

9.7.1.3 Identifying Thinking at Stage 3 and Above

Individuals at stage 3 within the conceptual sequence hold more detailed and consistent ideas about the natures of science and religion than individuals at stage 2. The tests developed to identify this kind of thinking were as follows:

- Students are judged to be at stage 3 or above if they generalise about the nature of the contradictions that they identify;
- If the student is consistent in regard to such issues as whether science opposes divine action then this is said to indicate thinking at stage 3;

- Students are judged to be at stage 3 or above if they distinguish between contradiction types, since this indicates that they have thought about the natures of science and religion and the relationship between them.

9.7.1.4 Identifying Thinking at Stage 4

Students at stage 4 within the conceptual sequence have considered different interpretations of science and religion and are able to consider how changing to an alternative view might alter an individual's perception of contradictions within the dilemmas.

Students who have considered alternative views of either science or religion but not both are said to be at stage 3-4.

To find out whether students are aware of other views of science and religion, the simplest method would seem to be to ask students directly whether they are aware that other views exist. This method, however, might suggest to students that there are multiple views when they had not previously considered this, and additionally, would not reveal whether the students have the skill to apply the knowledge.

The method that was used to probe students' awareness of multiple views was to ask students to identify the contradictions that they perceived to be real (perceived by them) and also any contradictions that they perceived to be apparent (perceived by others). The tests that were applied to identify thinking at stage 3-4 and at stage 4 were:

- If a student identifies contradictions as ones that other people might perceive but which the student does not perceive then this indicates that the student is aware of multiple ways to interpret scientific and/or religious information (indicating stage 3-4 or above);

- The test for thinking at stage 4 is that when describing the types of contradictions that people perceive, the student refers to multiple views of both science and religion.

9.8 Examples

Examples from the transcripts are given in Table 9.

Table 9

How Students Respond to the Apparent Contradictions

Stage	Approach	Quotation
Stage 1: Juvenile	Juvenile - religious	When I was younger, I just accepted the religious beliefs and what the Bible said. Science didn't play a role (MU5 Creation).
Stage 2: Narrative:	These are examples of terse contradictions	The contradiction is that science says it happened one way and religion says it happened another (MU6).
		Clearly there's a contradiction because they say different things (MU36).
		The contradiction is that they're totally different beliefs (MU8).
Stage 3 Unexamined Principled	The student identifies the contradiction-type of divine creation	One says God created it (the Universe) versus the other says it just happened (MU27)
	The student identifies the contradiction-type of divine creation	Science says things happened because of some fundamental law of nature versus the religious view is that God had a guiding hand (MU36).
	In this rationale, a reference to the nature of science is made; a principle that is perceived to be a science principle is rejected.	I've basically rejected what I've been taught in science. Scientists are too narrow-minded. Science is wrong. My own theory is the universe is meaningful (MU31).

	In this rationale, the contradiction-type of divine creation is discussed separately	Science has evolution with facts like fossils. But I don't know what they say about the start. God created it and now it's following the plan (MU20).
Stage 3-4: Reflects on the nature of religion but not on the nature of science	The nature of religion is questioned	There is a way to combine them but I'm not sure how. You have to look at religion in a different way, knowing science. I think God created science (MU30).
	The nature of religion is questioned	It contradicts if you think of the Bible literally. But if It's not literal it's OK (MU29).
Stage 4: Expert-Philosophical:	The individual at this stage reflects on the natures of science, religion and reality and forms a considered personal view.	There was not an example of stage 4 thinking in the transcripts of the interviews with students.

9.9 Chapter Conclusion

In this chapter it was explained that a dimension of developmental levels was identified in the transcripts based on the way that students identified apparent contradictions. The levels were extended by studying the approaches that students said they took in the past and by considering the approaches described in the academic literature. A conceptual sequence was constructed to describe how individuals might advance in their thinking about these kinds of dilemmas from novice to expert.

The premise that underlies the conceptual sequence is that the scope of enquiry enlarges upon advancement. Thus at stage 1, the individual accepts information in an unquestioning manner. At the more advanced levels, previous assumptions are opened to critical analysis.

The argument is that those who are more advanced in their thinking in this area reflect on issues that are not addressed by individuals who are less advanced. Thus an individual who was taught that the Biblical account of the Creation is allegorical and who did not consider any other view would be at a lower stage than another individual who made a reflective decision to take an allegorical view rather than a literal one. This description meets the requirement that the deduction of an individual's state of cognitive development does not depend on an analysis of the individual's beliefs. Children and experts have a wide range of beliefs. The conceptual sequence devised in this project is also one that seems to be compatible with accepted theories of cognitive development such as Piaget's theory of cognitive development of 1952 and Goldman's theory of religious development of 1965.

To accompany this conceptual sequence, in this chapter a set of characteristics were developed that can be used to identify the thinking of individuals at each of the stages in the sequence. The relevant skills and understandings were detected by asking such questions of the data as – were the contradictions terse, wordy or standard? Did the student exhibit an awareness of different contradiction-types, distinguishing for example between contradictions relating to divine action from contradictions relating to Biblical data? Did the student show evidence of an awareness of multiple views of science and religion, by discussing contradictions that he or she perceived to be apparent only?

At the beginning of this chapter two ways to provide insights into a student's approach were outlined. One way is to give a generalisation about the students' inferred views of science and of religion, based on the contradictions that the student perceives. The other way is to describe the student's depth of thinking, which also affects the way the student responds to the dilemma.

The results of the combined methods of analysis are presented in Chapters 13. At this point I turn to the other area of research that was summarised at the beginning of this chapter. This is the development of a template that shows how different views of science and religion interact to produce different types of perceived contradictions.

CHAPTER 10
THE CONTRADICTION-TYPE METHOD OF ANALYSIS

10.1 Overview

The Contradiction-type analysis method draws information about the characteristics of students' thinking by probing the types of contradictions that the students identify in the three written dilemmas. The analysis method applies only to the Engaged approaches. For the other four categories of approaches, the student does not identify a contradiction and Contradiction-type analysis is not applicable. On most occasions when students studied the written dilemmas they took an Engaged approach.

The review of the academic literature revealed that there was not an existing formalised system to relate perceived contradictions with particular views of science and religion. To construct such a system a selection of views of science and religion were drawn from the academic literature.

This sample of views, from what was presumed to be the most developed part of the population, was useful in two ways. Firstly these views provided an ideal model of what a rational and consistent observer would say about the relationship, which could be compared with the responses made by the undergraduate students in the study. Secondly the views of these experts were studied to form an understanding of the characteristics of the most advanced category within the conceptual sequence of cognitive development.

The views drawn from the literature were labelled the "Standard views". A table of relationships was constructed that shows how these different views of science and religion combine to produce the perception of particular types of contradictions. It will be argued that this table shows that there is a theoretical basis for asserting that the

contradictions an individual perceives to exist are related to the views of science and religion held by that individual, provided those views are consistent;

These relationships were used to develop an analysis method that inferred the Standard views of science and religion that would theoretically lead an individual to perceive particular patterns of standard contradictions.

10.2 Drawing Views of Science and Religion from the Literature

This section describes the way in which particular views of science and religion were drawn from the literature.

10.2.1 Limiting the Size of the Task

There are many different views about the natures of science and religion. The task of collating a set of views for this project was not as daunting as it may sound, however, once the decision was made to focus on the literature that discusses the relationship between science and religion. This is a smaller and more practical task than reviewing the immense literature on the nature of science and the similarly immense literature on the nature of religion.

10.2.2 Key Debates that are Relevant to This Research

Drawing on the literature review, it was judged that the apparent contradictions between science and religion relate to a few questions (see Chapter 2.6). The questions are:

- Divine creation: The question of how to interpret claims of divine creation: Did God plan the fate of His creation by building the future into the original design, or is the Universe evolving naturally from a Godless beginning? Davies reports that many scientists say there is no longer any need for a supernatural Creator, because the universe may have burst spontaneously into existence, naturally. He adds, however, that there are other reasons to argue that the Universe has a Creator (Davies, 1992).

- Theistic action: The question of whether God can guide events in the universe in an ongoing way. Some views of science oppose the possibility of acts of God in the physical world. In response, many religious scientists argue that God can guide events in a hidden way through quantum events.

- Miraculous action: The question of how to interpret claims of miracles. Is there a way for God to act apparently miraculously eg can God set a bush ablaze in such a way that it does not burn up? How can science be adapted from its currently accepted form in order to encompass this possibility? Many scientists say that the idea of miracles is not compatible with what science has revealed about how the universe operates.

- Biblical events and data: The question of how to interpret descriptions of events and data in the Bible such as the age of the earth. This question remains an important one for many members of the public, although most religious scientists feel that it has been answered (Drees, 1996). This area of debate interacts with the debate over miraculous action. There are many descriptions of miracles in the Bible and someone who believes that the Bible is inerrant must surely therefore support the idea that God can act miraculously.

- The division of divine action into three types was proposed by Polkinghorne (1998a). The labels and the definitions that are used in this thesis are modifications of Polkinghorne's scheme. Poole (1985) also proposed a scheme for understanding the different types of apparent contradictions that may arise, saying they are factual, supernatural or ethical. Ethical issues are not addressed here, and in the conceptual sequence I present here supernatural contradictions are subdivided into three types.

10.2.3 Perceptions of the Nature of Science within these Debates: How to Interpret Claims of Divine Action

The first debate relates to the kinds of divine action that are scientifically acceptable in the universe. Some people argue that science, which describes the universe in physical terms, "is the only reliable path to knowledge" (Barbour, 1988, p. 22). This is the key principle of Scientific Materialism and it represents the most extreme position in this debate. Scientific Materialists believe that an assertion of any kind of divine action must be rejected. In fact, the scientific principle is that assertions of supernatural acts must be rejected (not only divine acts) but for the purpose of the current study, in order to produce simple statements of apparent contradictions, the only kind of supernatural act that will be referred to is a divine one.

A second position in the debate is that of Scientific Determinism. This is the view that science opposes divine action on a day-to-day basis, but that it is scientifically acceptable to say that God designed the universe and set it going. This view, which is described in Chapter 2.6.2, became prominent after the establishment of Classical Newtonian physics (Polkinghorne, 1998a).

A third position is Scientific Operationalism, which is the view that science is silent on the issue of discrete theistic action, neither ruling it out, nor supporting it. This view became prominent following the establishment of Quantum Physics which seemed to show that nature is not totally deterministic, and that there is potentially room for God to achieve macroscopic changes in the universe by invisibly manipulating the outcomes of quantum events.

A fourth position will be defined for this thesis that mainstream science is Scientific Openness. This position is defined to covers the proposal by Polkinghorne (1990) that miraculous events, such as the virgin birth, are events that occur in unique circumstances. Polkinghorne explains that these circumstances would be arranged by God though his "usual" process of providential action (p. 14).

10.2.4 A Guiding Principle Regarding the Physical Accuracy of Scientific Assertions

For the purpose of this thesis, then, an individual's view of science includes a principle that describes the kinds of divine action that are scientifically acceptable. In addition to this principle, it would seem logical to have a second principle that describes the perceived physical accuracy of science. This is indeed an aspect of the nature of science that is widely discussed.

There are some individuals who believe that the so-called "facts" of science are inerrant. Driver reports that this view is frequently held by school students (Driver, 1988). There are others who describe this view as naive. Hume (1874) observed that even after repeated observations of an object, we are not able to insist on any inference about that object or another beyond these examples of which we have had experience. Popper argued that no number of singular observations can conclusively verify a universal statement (Popper, 1959). In the literature review, it was noted that Barbour (1988) and Polkinghorne (1986) both stated that they do not necessarily reformulate traditional religious claims if the opposing scientific finding or theory is out of the mainstream. The term "mainstream" was first used by Barbour to describe the kind of science that is "widely accepted" (Barbour, 1988, p. 41).

Creationists, in contrast, believe that several assertions made by mainstream science are in error. In support of their argument they point out that the content of science is constantly being changed and updated as new discoveries are made. In their view, given the fluidity of science, it is more rational to trust the Bible as a source of accurate data. The Creationists' view could be labelled "Irregular", meaning that science has much to

offer but has some important errors. A fourth, more extreme position would be that science provides no useful insight about the workings of the universe. This view will be labelled "Anti-science".

Drawing on this range of principles, Table 10 presents selected views of science that may be held. The labels, which were devised for this project, for each of the views consist of three parts. The first part indicates how assertions of scientific data are broadly interpreted (they may be reformulated if found in conflict with Biblical data; accepted if mainstream; perceived to be inerrant or rejected universally); the second part is simply the word "scientific" and the third part indicates which kinds of assertions of divine action are tolerated (openness, operationalism, determinism or materialism).

Table 10

Selected Views about the Nature of Science

View of Nature of Science that Advocates These Principles	**Principle Regarding the Possibility of Supernatural Intervention**	**Principle Regarding the Physical Accuracy of Science**
Inerrant scientific Materialism:	Science asserts Scientific Materialism; that is, Science opposes any kind of divine action	Science asserts that the data of all current science is accurate.
Mainstream Scientific Materialism:	Science asserts Scientific Materialism; that is, Science opposes any kind of divine action	Science asserts that the data of mainstream science is accurate.
Mainstream Scientific Determinism (Classical science)	Science asserts Determinacy: science permits divine creation but opposes theistic action	Science asserts that the data of mainstream science is accurate.
Mainstream Scientific Operationalism (Barbour's Critical Realism)	Science asserts Operationalism: Science permits divine creation and discrete theistic action but opposes miraculous action.	Science asserts that the data of mainstream science is accurate.
Mainstream Scientific openness (Polkinghorne's View of Science)	Science permits the possibility of miraculous action and discrete theistic action and divine creation.	Science asserts that the data of mainstream science is accurate.
Reformulated Scientific Openness (Creation Science)	Science permits the possibility of Miraculous Intervention and Theistic and divine creation.	Science asserts that the data of mainstream science contains errors.
Antiscience	Science is not a valid way of understanding the world	Scientific data is mythical

10.2.5 Perceptions of the Nature of Religion within these Debates

Views about the nature of religion vary greatly. For this research a key question is how to interpret Biblical descriptions of events and data. A second question which is often

addressed simultaneously is whether to accept the possibility of miraculous action. The Bible contains many examples of events that are said to be miracles. Those who believe that religion requires a literal interpretation of the Bible could be said to believe that religion asserts the inerrancy of Biblical data and also the possibility of miraculous action.

Another question that is relevant when thinking about the nature of religion is whether religion asserts theistic action. Theism is a belief in a God who has performed divine acts since the creation. Deism, in contrast, is a belief in a God who created the universe, who now watches remotely.

Examples, then of principles that can be said to define an individual's view of the nature of religion are:

- The Bible is to be read literally regarding events and data; or The Bible is intended to be reformulated regarding events and data; or mythical – the view that the Bible is mythical regarding events and data;

- Religion asserts all kinds of divine action are possible including miraculous action; or religion asserts that discrete divine action is possible. This includes discrete theistic action and divine creation but not miraculous action; or religion asserts divine creation (only) and Atheism – the view that there is no divine action.

By drawing on these principles, Table 11 presents a selection of views regarding the nature of religion for the purpose of this research. Each view is labelled with three terms. The first term indicates how assertions of Biblical data should be interpreted; the second term indicates how assertions of divine action should be interpreted. The third term does not provide any new information but describes the view overall as Theistic, Deistic or Atheistic.

Table 11

Selected Views about the Nature of Religion

View of Nature of Religion That Advocates These Principles	**Principle Regarding the Nature of Divine Intervention**	**Principle Regarding the Accuracy of Biblical events and data**
Biblical Literalism (Literal-Miraculous-Theism)	Religion asserts the possibility of all kinds of divine action including miraculous action	Religion asserts that the Bible presents literal events and data
Polkinghorne's View of religion within Consonance (Reformulated-Miraculous Theism)	Religion asserts the possibility of all kinds of divine action including miraculous action	Religion asserts that traditional Biblical data and events should be reformulated
Barbour's View of Religion within Assimilation: (Reformulated discrete-Theism)	Religion asserts the possibility of discrete theistic action and divine creation	Religion asserts that traditional Biblical data and events should be reformulated
Deism (Reformulated Deism)	Religion asserts the possibility of divine creation only	Religion asserts that the Bible presents mythical events and data
Atheism	The view that there is no divine action of any kind	The view that the Bible presents mythical events and data

10.2.6 A Range of Stances on the Nature of Science and of Religion

In overview, then, the principles given above are principles of science and religion that guide individuals when they reflect on a science-religion dilemma.

Contradictions arise when an individual's view of science and the view of religion combine to produce incompatible scientific and religious principles, such as: Science opposes divine creation; religion asserts divine creation. An individual who believed that science and religion contain these principles respectively would draw the conclusion that science and religion contradict on the issue of divine creation.

10.2.7 Case Studies of Expert Views from the Literature

10.2.7.1 The Four Types of Contradictions

With four types of apparent contradiction now defined, the comparative differences and the internal consistency of these Expert-Philosophical approaches can be shown. It can also be shown that these contradiction-types and views of science and religion are espoused by selected academics.

The four types of apparent contradiction are:

- Contradictions regarding Biblical events and data;
- Contradictions regarding divine creation;
- Contradictions regarding discrete theistic action;
- Contradictions regarding Miraculous Intervention.

To show how these three types of contradiction can be used to highlight the differences between the major approaches, consider how a Scientific Materialist, a Creationist, a Deistic-Determinist and an Assimilationist would respond to each of these types of contradiction.

10.2.7.2 Biblical Events and Data

When looking at an apparent contradiction regarding Biblical data or events, the source of alleged religious data is the Literal Bible. The alleged religious assertions are therefore described as Biblical data and events. In a corresponding fashion, a label was required for the contradictory alleged scientific data. Creationists dispute that the alleged scientific assertions of data in an apparent contradiction are truly scientific. Since these assertions are not universally agreed to be part of science, a label was required for them that was more objective. The label chosen here was "mainstream science". Barbour (1988) uses

the term mainstream science to describe current descriptions of the physical world that most scientists believe are beyond reasonable doubt.

Interestingly given an apparent contradiction about Biblical events and data, both Materialists and Assimilationists accept the assertions of Mainstream physical science over literal religion. To balance this view, the Assimilationists' view is that religion does not require that references to structures, time-spans and dimensions be read literally if they are contradicted by physical science (Barbour, 1988). The Materialist's view is that religion is not valuable.

In the case of Creationism, assertions about physical processes in the Literal Bible are accepted and are said to be part of religion. Creationists contend that when the words in the Bible are reformulated in "word games", the Bible loses authority (Stambaugh, 1991, p. 76). To balance this view, assertions about physical processes that are made by mainstream science are reformulated to produce the Creationists' view of science, namely, Creation science.

10.2.7.3 Types of Contradiction Relating to Divine Action

In the proposed conceptual sequence, there are three types of divine action: miraculous action, divine creation and discrete theistic action. Assimilationists do not make a distinction between the two types of discrete divine action. If an apparent contradiction refers to a divine act in which no physical laws are broken, then Assimilationists say that this is not a real contradiction, since in their views, science does not oppose hidden divine action. This view is balanced by the claim that religion asserts hidden divine action.

In contrast, Deists (who in this system would be described as Deistic-Determinists) do see a difference between divine creation and discrete theistic action. These individuals support the idea of the divine creation but not theistic action.

The Scientific Materialists have another contrasting but consistent view, in which all three kinds of divine action are rejected, and in which the nature of science is said to oppose the possibility of any kind of supernatural intervention in the physical universe.

10.2.7.4 Miracles

Miracles are unique or rare events that cannot be explained in terms of ordinary natural processes. The issue that is raised in the academic literature is whether it is acceptable to break a natural law that is described by Mainstream science.

Assimilationists are of the view that the laws of natural mainstream science cannot be broken and that science does not oppose discrete divine action. The approach taken by the Assimilationists on encountering an apparent contradiction regarding a miracle is to say that a physically possible event took place, arranged by God (see for example Haught, 1995; Houghton, 1995b). To balance this view, it is said that in religion, assertions of miracles should be interpreted as metaphors or allegories. By way of an example, there is this comment by Berry:

> Clearly he (God) could have made Eve from one of Adam's ribs, but that does not mean that he actually did so ... It is fully consonant with Genesis that God created Adam in the body of a Near Eastern farmer comparatively recently in archaeological terms (1996, p. 50).

On some occasions, this approach becomes highly contentious. For example, Bishop Barnes applied this approach to the virgin birth, saying that in his view, God guided events to the desired outcome, but did not miraculously cause Mary to conceive (Barnes, 1948). In other words, in Barnes' view, Jesus had a human father.

It is interesting to look at how religious assertions of miracles are interpreted by holders of the view of Creationism. The label for this approach can unambiguously be given as Creationism since this label specifies a view of science and a view of religion. The purpose of the study was to test whether there is a set of principles that are compatible with Creationism and that involve giving consistent responses to these three kinds of apparent contradiction. It was found that it is indeed possible to define a set of principles of this kind.

With regard to assertions about miraculous action, in Creationism these are accepted as true. Once again, the Creationists believe that other groups misunderstand the natures of

science and religion and that this leads them to reject what the Creationists consider to be the truth.

Examples of Creationists making this response can be found in the literature. For example, Vardiman, a supporter of Young Earth Creationism, explains, "The presence of supernatural 'process' during Creation is essential to our approach" (Vardiman, 2000, p. 5).

Humphreys (2000) also believes that science leaves room for miracles. Referring to radioactive decay, he says:

> It appears that Christ already has direct control of the nuclear (and other) forces, and furthermore that He is intimately involved with them. So even if we cannot follow all the links in the chain of causes back past a certain point, we can be confident that Jesus Christ is not only at the end of it, but at every link along the way.
>
> (Humphreys, 2000, p. 367)

10.2.7.5 A Fuller Range of Views of Science and Religion

By drawing on examples in the literature, this section has provided qualitative evidence that supporters of the major approaches respond consistently to the different types of contradiction between science and religion if the contradictions are defined in the specified way. Six views of the relationship were set out as a way to discover a preliminary set of component views of science and religion

10.2.8 Summary Table of Relationships

Given the preceding work, pairs of Standard views of science and religion can now be selected and a table can be generated that shows the contradictions that would be perceived by someone holding these Standard views. A table of such relationships is shown in Table 12 (see page 180).

Before presenting this table, a few explanations of the terms contained in the table will be given here.

Firstly, the table does not contain every possible combination of the principles outlined to this point, but only those that seemed useful.

The top row of Table 12 sets out different views of the nature of religion; the first column presents views of the nature of science. This first row and first column are shaded to help them to stand out from the body of the table. The body of the table presents the perceived relationship between science and religion for a holder of these views. It is interesting to note that some combinations produce the conditions for one kind of contradiction, while others produce the conditions for several kinds of contradiction.

Where the paired scientific and religious views produce a view of the relationship that is commonly described these particular views have been labelled. Examples are Assimilation, Creationism, Biblical Literalism, Scientific Materialism. As shown, the labels apply at different levels. Some are labels for views of science (or religion) and some like Assimilation and Creationism are views about the relationship between science and religion.

Table 12

Views of Science, Religion and the Relationship

	BIBLICAL LITERALISM **(Literal Miraculous Theism)** Religion asserts miraculous action, discrete theistic action, and divine creation. Religion asserts literal Biblical data	**POLKINGHORNE'S VIEW OF RELIGION** **(Reformulated Miraculous Theism)** Religion asserts miraculous action, discrete theistic action, and divine creation. Religion does not assert literal Biblical data	**RELIGION IN ASSIMILATION** **(Reformulated Discrete Theism)** Religion asserts discrete theistic action, and divine creation. Religion does not assert literal Biblical data	**REFORMULATED DEISM** **(Reformulated Deism)** Religion asserts divine creation. Religion asserts that the Bible is not a source of data	**ATHEISM** **(Mythical and No Divine Action)**
SCIENTIFIC MATERIALISM **(Mainstream/Inerrant Materialism)** Science opposes all kinds of divine action; Science asserts that the data of mainstream science is accurate.	**TOTAL CONFLICT** Contradictions on events and data, and on all kinds of divine action.	Contradictions on some events and data, and on all kinds of divine action.	Contradictions on theistic action and divine creation.	Contradictions on divine creation	**SCIENTIFIC MATERIALISM/ NATURALISM** No contest
CLOCKWORK UNIVERSE **(Mainstream Scientific Determinism)** Science asserts Determinacy and permits divine creation; Science asserts that the data of mainstream science is accurate.	Contradictions on events and data, and theistic action (Miraculous and discrete).	Contradictions on theistic action (Miraculous and discrete).	Contradictions on theistic action.	**DEISM** No contradictions	No contest

CRITICAL REALISM **(Mainstream Scientific Operationalism)** Science permits Theistic and divine creation; Science asserts that the data of mainstream science is accurate.	Contradictions on miraculous action.	Contradictions on miraculous action.	**ASSIMILATION** No contradictions	No contradictions	No Contest
POLKINGHORNE'S VISIONARY SCIENCE **(Mainstream Scientific Openness)** Science does not oppose miraculous action, theistic action and divine creation. Science asserts that the data of mainstream science is accurate.	Contradictions on events and data	**CONSONANCE** No contradictions	No contradictions	No contradictions	No Contest
CREATION SCIENCE **(Reformulated-Openness)** Science permits miraculous action and Theistic and divine creation; Science asserts that mainstream physical science contains some errors.	**CREATIONISM** No Contradictions	No contradictions	No contradictions	No contradictions	No Contest
ANTISCIENCE	No contest	No contest	No contest	No contest	No contest

10.2.9 Summary and Discussion of the Views Presented in Table 12

The six views of the relationship together with the Standard views of science and religion within them that were drawn from the literature were:

- Scientific Materialism (Mainstream Scientific Materialism and Atheism);
- Assimilation (Mainstream Operational Science and Reformulated Discrete Religion);
- Consonance (Mainstream Visionary Science and Miraculous Reformulated Religion);
- Deistic-Determinacy (Mainstream Scientific Determinacy and Reformulated Deism);
- Creationism (Miraculous Creation Science and Biblical Literalism);
- Biblical Literalism-Anti-science (Biblical Literalism and Anti-science).

As Table 12 shows, the views of science and religion within these views of the relationship can be extracted and recombined in different ways. Each resulting view of the relationship contains a view of science and a view of religion. In turn, the definitions of science and religion each contain two principles. One principle relates to the correct interpretation of Biblical data and the other relates to the possibility of divine action (described as divine creation, discrete theistic action and miraculous action). Contradictions were formed when incompatible principles from science and religion were brought together. The hypothesis presented at the beginning of this chapter has been shown to be true in this context.

It is interesting to note that most of the original pairings lead to the view that there are no contradictions between science and religion. Examples of accepted pairings are: Deism combined with Determinism; Operationalism combined with Discrete Theistic religion.

The accepted pairings that do produce contradictions are those in which science or religion is totally rejected, such as the combination of atheism with Scientific Materialism.

On reviewing the information presented in Table 12, it was reassuring to discover that it is compatible with Barbour's observation that those who hold the views of Biblical literalism and/or Scientific Materialism regard the relationship between science and religion as one of conflict (Barbour, 1988).

10.3 Students' Views of Science and Religion

10.3.1 Why Compare Students' Views with Views in the Literature

The aim when devising this part of the analysis system was that it would provide a way to infer students' views of science and religion from the contradictions that they identified.

There was a basis for believing that the principles that guided the thinking of the students were similar to the principles within the Standard views that are discussed in the literature. Earlier rounds of analysis had shown that several students identified the apparent contradictions that were similar to those described in the formal academic literature from which the definitions of the Standard views were drawn. These findings were first presented in Chapter 6.6.

To strengthen the case that students' views were similar to the views in the literature, an attempt was made to match students' own descriptions of science and religion with the Standard views. Students' descriptions, however, did not reveal the kinds of information required at this point in the project such as whether science was seen as equivalent to scientific materialism. (The responses are summarised in Appendix D.) As a result, an analysis of students' stated views about science and religion were of limited value in this regard. The results are presented in Chapter 13.4.6.3.

10.3.2 The Types of Apparent Contradiction in the Written Dilemmas

The written dilemmas section of the interview provided students with the opportunity to identify any or all of the four types of contradiction described in the analysis system. Between the three dilemmas there were two and sometimes three occasions on which each type could be identified, which provided the opportunity to assess the consistency of students' thinking.

In Chapter 5, where the details of the dilemmas were first set out, an overview of kinds of contradictions that might be perceived within each of the dilemmas was presented in Table 4 on p. 77. The following paragraphs refer to the dilemmas in more detail with references to each of the contradiction-types that might be perceived in each.

10.3.2.1 Creation Dilemma

The written dilemma on the topic of the Creation can be used to discover how students think about the Contradiction-type of divine creation. The relevant analysis questions at this point are: Does the student believe that religion asserts divine creation? Does the student believe that science opposes divine creation? This is a useful way to separate students who hold a view resembling Scientific Determinacy – who would be expected to indicate that they do not see a contradiction on the issue of divine creation, from students who hold a view resembling Scientific Materialism – who would be expected to identify a contradiction on this point.

This is not the only contradiction that a student might perceive to exist between science and religion on this topic. A student, for example, who believes that religion requires us to read the Bible literally might raise a contradiction regarding Biblical events and data. Because there are many ways to interpret the allegedly religious and scientific paragraphs available, it is predicted that students would identify different contradictions because of the different interpretations they adopt.

10.3.2.2 Life Dilemma

The second dilemma presents scientific and religious accounts of how life began. There are a number of ways in which these accounts can be interpreted. Some people say that religion asserts that the circumstances that lead to life were written into God's plan at the time of the Creation. In this case, the potential contradiction between science and religion is in regard to an act of divine creation.

Alternatively, some people believe that religion asserts that God began life with a separate act after the Creation. This is an example of a theistic action. It could be miraculous action (as per the Adam and Eve story) or a discrete act (such as the bringing together of life-producing chemicals). If the individual has not considered the exact nature of the divine act, it can be simply described as a theistic action. The potential contradictions for holders of these religious principles – if science is said to oppose them - are theistic action, discrete theistic action, miraculous action and Biblical data. In this way, this topic presents the potential for all the contradiction-types to be raised.

10.3.2.3 Prayer Dilemma

The third dilemma does not refer to a specific Biblical event, and so the question of how to interpret Biblical events and data does not arise. The dilemma asks students to address the question of whether God can respond to prayers, which focuses on the question of theistic action. This is the question of whether and how God achieves change in the current universe, in response to prayer for example. The ways that God could respond to prayers would be through miraculous action or through discrete theistic action. Based on the literature review it was concluded that there are some authors who believe that religion proposes the possibility of both of these kinds of action (Polkinghorne, 1998a); meanwhile others believe that God only works discretely (Barbour, 1988).

10.3.2.4 Summary of Dilemma Apparent Contradictions

In summary, the types of contradiction that are predicted to be perceived for each topic are shown in Table 13.

Table 13

Types of Apparent Contradiction in Each Topic

Dilemma	**Contradiction Types**				
Creation	Biblical data	Divine creation			Miraculous action
Life	Biblical data	Divine creation	Theistic action	Discrete theistic action	Miraculous action
Prayer			Theistic action	Discrete theistic action	Miraculous action

Table 13 shows the types of contradiction that could be raised for each topic. Other views about the natures of science and religion are possible and these could lead to the perception of other contradictions. This list was based on selected views drawn from the literature.

Looking at those views, it can be predicted that those who regard religion as equivalent to Biblical Literalism would perceive a contradiction between Biblical data and the data of mainstream science when studying the first topic and also the second topic.

Those who regard science as equivalent to Scientific Determinism would theoretically not perceive a contradiction on the issue of divine creation in the first topic, but would perceive a contradiction on the issue of theistic action in the third.

In this way, the types of contradiction perceived can be related to different views of science and religion.

10.4 Additions to the Analysis System

A trial round of analysis was applied to the 20 student interview transcripts and a number of additions were subsequently made to the analysis process to extend it for use with students' interviews.

10.4.1 Types of Contradictions Identified by Students

The first extension was to insert more categories to describe the types of contradictions that students identified. The trial analysis showed that not every contradiction identified by students could be matched with a Standard contradiction. The non-standard types of contradiction in the transcripts were classified as Wordy contradictions and Terse contradictions.

10.4.1.1 Wordy Contradictions

One type of contradiction identified by students was labelled "Wordy Contradiction with Biblical data". These contradictions included references to divine action and Biblical events without drawing a distinction between them. They were said to indicate stage 2 thinking. Because the description of the contradiction includes references to literal Biblical events and data, it could be inferred that the student saw religion as asserting that a literal interpretation is the correct interpretation of Biblical accounts.

10.4.1.2 Terse Contradictions

Another kind of contradiction was labelled "Terse". These were brief comments that did not reveal individual principles within a student's views about science or religion. An example was this comment by MU32 about the Creation:

> "Science has one explanation and religion has another.
> Definitely a contradiction."

Such comments may indicate disengagement or they may also be an indication of the kind of thinking that marks the earlier stages.

In all this produced three broad categories: Wordy, Terse and Standard. In the cases of Standard contradictions, the nature of the contradiction was then analysed further.

10.4.2 Additions to the Standard Contradiction-types

Additional types of Standard contradictions were defined on finding that students did not identify the four contradiction-types exactly as they were identified in the original template.

One of the features of this study was that students identified the contradictions themselves. This method was chosen because when students identified the contradictions that they perceived, this provided valuable information about their thinking. As a result, students were not asked to address each contradiction-type that was outlined in the template of views and contradictions. One of the outcomes of choosing this methodology when students identified contradictions, they only raised the contradictions that they were aware of, and they only differentiate between types of contradictions in a way that is relevant to their views.

(In contrast, individuals at the Expert-Philosophical stage of thinking might differentiate between many contradiction-types in order to comment on the issues raised by holders of other views.)

When the transcripts were studied, it was found that the students in the current group did not identify contradictions relating to discrete theistic action, but they did identify contradictions relating to theistic action without specifying whether the action was discrete or miraculous.

For this reason, when the template of contradictions was constructed for use with the student interviews, a column was inserted for "theistic action". A theistic act is a divine

act that took place after the time of the creation and may be miraculous or may be discrete. The presentation of the template in Table 13 includes this column.

The principles that students were inferred to hold within their views of science and religion also mostly related to the more general issue of theistic action rather than to miraculous and discrete theistic action. To describe the religious view these students were inferred to hold, the term "Theism" was added to the set of religious views. Theism is a belief in ongoing divine action. In some cases, more was known about the student's view of religion and it was possible to say for example that a student's view was "Reformulated Theism". In this view, the student believes that religion requires the reformulation of Biblical events and data to fit with the data of mainstream science. Theism also includes Biblical Literalism, a religious view which asserts the possibility of miracles and which asserts that Biblical events and data are literally true.

10.4.3 Additions to the Prescribed Views of Religion

The sets of principles that identified the views of science and religion in the first template of relationships were highly prescriptive. To say that an individual held any particular pairs of views, it was necessary to know the individual's views of science and religion in regard to the four principles discussed. This level of detail is not always gleaned from the interviews.

The scientific paragraphs in these written dilemmas did not present any assertions that are considered by a majority of scientists to be questionable. This meant that there was not an opportunity to test whether students distinguished as does Barbour (1988) between mainstream science and all science. The principle of scientific inerrancy was therefore not tested in the current interview design. As a result, the categories defined to cover students' views of science do not specify whether science is "mainstream" or "inerrant".

In general, students only identified one or two contradictions for each dilemma. When the information gleaned from these contradictions was compiled for each dilemma it rarely revealed all the principles that are specified in order to make a perfect match with a

particular view in the final set. A way was needed to say something about the nature of these people's views based on the information available.

The first response to this issue that was made was to define additional views of science and religion that were less detailed in terms of the principles they contained. Thus if a student indicated that religion asserts the possibility of ongoing divine action, then this view of religion can be said to be Theism. In some cases, more may be known about the student's views. These additional details can be presented by inventing and referring to subcategories of these broadly stated views.

Three religious views and two scientific views were added to the system to cover the range of views held by students. These are shown in Table 14 and Table 15. In the finished analysis system, the list of categories was extended to cover the experts' and students' views of science and religion. The range of views produced in this way was wide, as it was drawn from individuals at all the relevant stages in the sequence. To elaborate on this last point, the students in the sample were at stages 2, 2-3, 3 and 3-4; the experts were at stage 4. Views of science and religion are not inferred for those at stage 1 because the conceptual sequence specifies that at this stage, children have not formed views.

Table 14

Students' Views of Religion

Views of Religion	**The Principles Asserted Within Each View**
Theism	◦ Theistic action and divine creation are asserted; ◦ Views on miracles and Biblical data are not given.
Reformulated Theism (a more defined view within Theism)	◦ Biblical events and data are meant to be reformulated; ◦ Theistic action and divine creation are asserted.
Deism	◦ Divine creation is asserted but not theistic action.

Table 15

Students' Views of Science

Views of Science	The Principles within each View
Scientific Materialism	○ There is no divine action of any kind in the universe; ○ The universe obeys laws; ○ Mainstream/all science data is correct.
Scientific Determinism	○ The universe obeys laws; ○ Mainstream/all science data is correct.

Two examples are given to show how students' views of science and religion were deduced from the contradictions they identified, using the conceptual sequence.

10.4.3.1 Example1: A Contradiction Regarding Theistic Action

The student MU3 responded to the written dilemma on the topic of prayer by identifying the following contradiction: "The contradiction is that there's a will that directs things versus things just happen".

This contradiction is categorised as a real contradiction on theistic action. Theistic action is one of the Standard contradiction-types. From the identification of this contradiction, it is deduced that for the topic of prayer the student believes that religion asserts theistic action (and so her view of religion is not theistic not deistic). At the same time, science is said to oppose theistic action. If these beliefs are found to be consistent for all three dilemmas, then it will be inferred that the student's view of religion is Theism and her view of science is Determinism or Materialism. This set of possibilities may be narrowed following an analysis of the other contradictions that the student perceived

10.4.3.2 Example 2: A Contradiction Regarding Biblical Events and Data

Having read the creation dilemma, the student MU5 described the following apparent contradiction:

> "Some people think there's a contradiction on whether the universe was created in six days or took billions of years to evolve. It depends on how you look at it. The seven days may not have been seven days so it may be OK with the Big Bang theory."

In this case, the student MU5 identifies an Apparent-only contradiction relating to Biblical data. She explains that others perceive a contradiction that she herself does not perceive to be real. The contradiction-type is Biblical events and data. The assertion of religion that is inferred from this contradiction is: "Religion asserts that the Bible is intended to be reformulated". The assertion of science is that science asserts mainstream science data. If these views are found to be consistently stated during her responses to the three dilemmas then it will be inferred that her view of religion is Reformulated Theism or Reformulated Deism and that her view of science is Mainstream or Inerrant.

10.5 Chapter Conclusion

This chapter described the Contradiction-type method of analysis which is a way to infer information about students' views of the natures of science and religion from the contradictions that they identify.

The analysis method was developed in the following way. A review of the literature revealed that the religious scientists and other academics working in this field frequently debate whether science repudiates divine action and whether descriptions of Biblical events and data are intended to be read as literally true. To cover the issues that are discussed most commonly in the literature, four types of contradiction were defined. Three types of contradiction related to the debate over different kinds of divine action and one type referred to Biblical events and data.

The suggestions as to how these contradictions can be resolved were also studied. A set of views of science and religion was drawn from the formal academic literature, reflecting the range of approaches that are described.

A table was drawn up to show how incompatible pairings of science and religion produce a perception of certain types of contradictions. The table of views was extended so that it could be used to analyse the written dilemma section of the interviews with students. The analysis method is to infer principles of science and religion from the contradictions that students identify. More principles are gathered as the student's response to each dilemma in turn is studied. The final collection of principles are studied for self-consistency and are matched with the appropriate views of science and religion in the analysis table.

Chapter 11 describes revisions that were made to the Written Dilemma approach model to accommodate the new analysis methods. The revised model shows the range of approaches that are taken by individuals at each developmental level. Chapter 12 presents the finished Written Dilemma analysis system which includes the main analysis methods described in the thesis, designed to probe students' stages of cognitive development (if the scheme is shown to be valid) and their views of science and religion.

CHAPTER 11
THE REVISED WRITTEN DILEMMA APPROACH MODEL

11.1 Introduction

The Written Dilemma approach model is a visual way of describing the approaches that individuals might take on encountering a science-religion dilemma. It shows the types of decisions that are involved in each approach. An early version of the model was presented in Chapter 8. Chapter 11 presents a revised version of the model which shows which approaches are available to students at each stage.

11.2 The Revisions

The revised model retained the idea of five main categories of approaches: Juvenile, Unconnected, Disengaged with undetermined belief, Disengaged with fixed belief and Engaged. Several of these categories were subdivided to identify groups of approaches with the category that relate to different stages within a conceptual sequence of cognitive development.

In the revised model, within a category (such as the category of Engaged approaches) it is shown that individuals at different stages have different ways of thinking about the dilemmas. Figure 7 (below) shows the subdivisions that were made to the five categories.

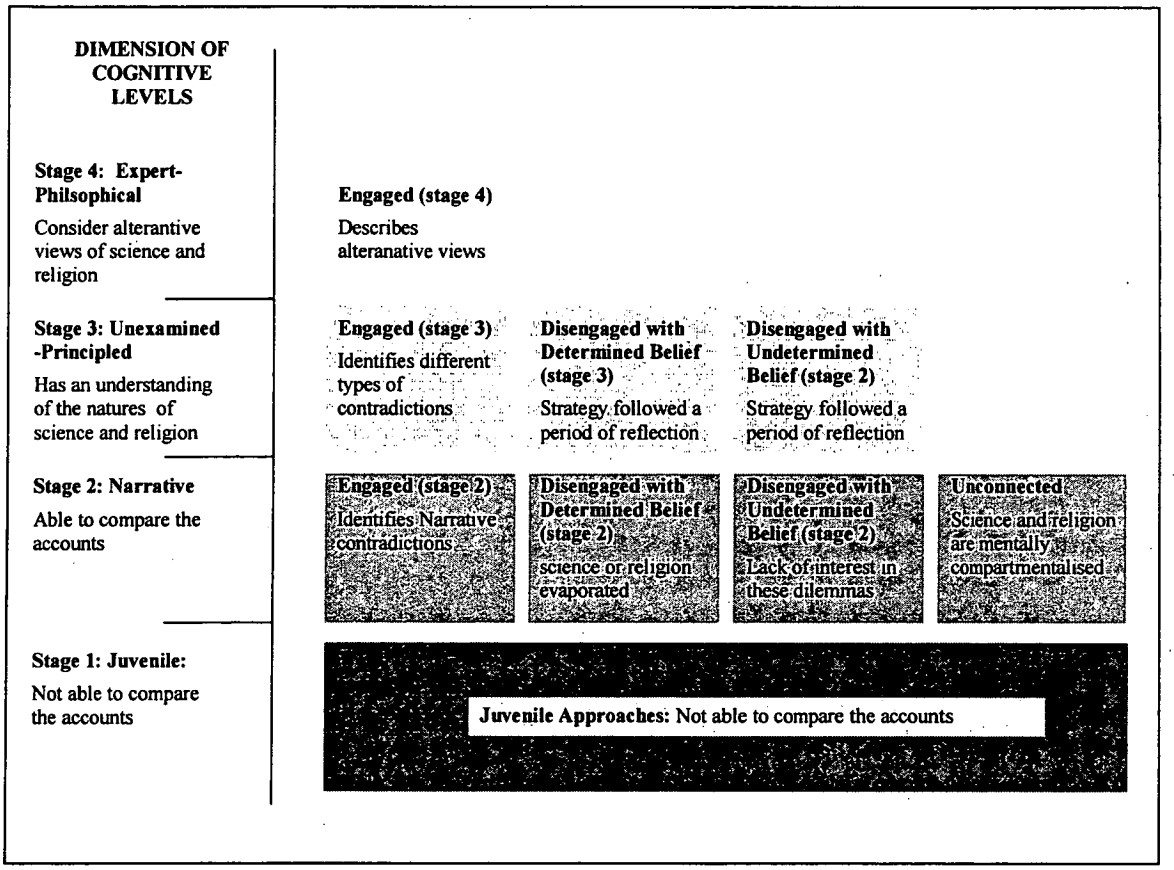

Figure 7. The dilemma approaches that are available at different stages

11.3 The Subcategories of Approaches

11.3.1 Juvenile Approaches

No subdivisions were made to the Juvenile category to show different levels of cognitive development because the category was defined to describe how individuals at the first stage approach a dilemma. Young children accept their beliefs unquestioningly from authorities such as their parents. At this stage, generalisations are not deduced or applied and there may be internal inconsistencies, and unusual ideas. Depending on how students are raised, their beliefs may be science-only, religion-only, combined, dualistic or a belief that is not based on science or religion.

11.3.2 Disengaged Approaches

In the sequence, the choice about whether to reflect on a science-religion dilemma can be made by individuals who are at any stage beyond Juvenile. From stage 2 onwards students can compare the information from science and religion and discover that science and religion offer different information.

Identifying the stage of a student who takes a disengaged approach in the sequence may not be straightforward. The stages have been defined in terms of the skills that are available to the student at each stage. When students disengage from the task of studying the dilemmas, it may not be clear whether they lack these skills or simply are disinclined to use them.

There are points in the interview transcripts when more can be learned about the depth of a student's thinking if he or she chooses not to identify contradictions, and this is when the student explains why the decision to disengage was made. In particular, it was noticeable that there were two distinct reasons given by students who chose to disengage having entirely rejected one field. The student MU36 indicated that religion had "evaporated" through inattention. This would seem to be a stage 2 approach. MU4, in contrast, said that he had rejected religion after reflection. This would seem to be a stage 3 approach.

The two categories of disengaged approaches were each divided into two subcategories.

11.3.3 Engaged Approaches

The category of Engaged Approaches was also subdivided. The new subcategories of Engaged approaches present more information about the kind of thinking that is involved at key steps. For example, there is a point in the sequence of steps at which the student identifies a contradiction. The revised model describes the types of contradiction that an individual might identify as terse, wordy or standard and relates the individual's ability to identify contradictions to his or her stage in the sequence.

The sequence of steps specified for this approach have also changed and the "action" term is no longer used. Comments that were previously labelled as actions were used to test the categorisation of the individual's belief. The new sequence is:

1. Is capable of comparing the accounts;

2. Encounters the accounts in attitudinal juxtaposition in the interview;

3. Reflects on the natures of science and religion to interpret the accounts;

4: Identifies an apparent contradiction (stage 2: terse or wordy; stage 3, 4: standard);

5: States the Real Relationship (stage 2, 3: single view; stage 4: multiple views);

6: States a Belief for the dilemma.

The updated model is shown in Figure 8.

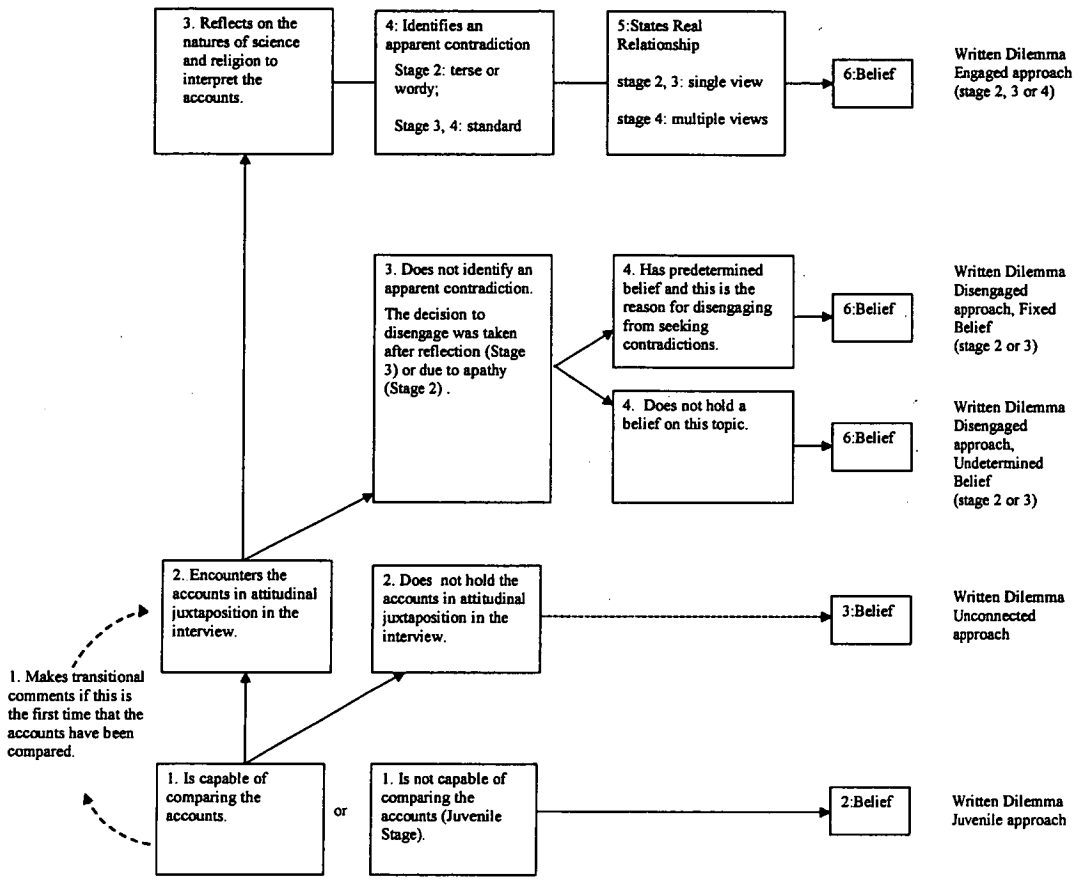

Figure 8. The revised Written Dilemma approach model.

11.4 How to Meaningfully Describe Students' Approaches

In Chapter 7.2 it was explained that there was an ongoing challenge in this project to construct meaningful descriptions of the different kinds of approaches. Based on the preceding work, it was deemed that the approach would set out the major decisions that the individual made having encountered a dilemma together with generalisations about the thinking that individual students or groups of students engaged in, such as strategies, prior beliefs about science and religion and cognitive limitations.

This led to the conclusion that in this thesis, presenting the following items of information would provide a meaningful description of an individual's approach:

- The category of the approach (Juvenile, Unconnected etc)
- The individual's stage in the sequence which can be expressed as a subcategory for the approach, for example, Engaged (stage 2);
- For stages 2 and above: The inferred views of science and of religion;
- For Engaged approaches, for each contradiction that is identified:
    - ◊ The real relationship: Real contradiction (refers to one view only); Real contradiction (refers to multiple views); Compatible (refers to one view only); Apparent-only (refers to multiple views);
    - ◊ A description of the contradiction as Wordy, Terse or Standard; If Standard, the Contradiction type is also given;
- The dilemma belief.

Examples of approaches written in this format are given below:

Example 1:

> Written Dilemma Juvenile approach (stage 1), religion only.

Example 2:

> Written Dilemma Unconnected approach (stage 1.5), combined.

Example 3:

> Written Dilemma Engaged approach (stage 2), materialism and deism*/theism*, Real contradiction on theistic action, undecided.

Example 4:

> Written Dilemma Disengaged approach with fixed beliefs (stage 3), materialism and deism, science-only.

Example 5:

> Written Dilemma Engaged approach (stage 4), mainstream operationalism and reformulated theism, apparent-only contradiction on discrete theistic action, combined.

The last example describes the approach that is taken by a supporter of Assimilation. The fourth example is an approach taken by an atheist who rejected religion after reflection. The third approach was taken by a student who was seeking to combine science and religion. Asterisks are used in this example to highlight where the individual's ideas are inconsistent.

In the description of the approach taken by a young child, fewer items of information are given. Students at a young age believe what their parents teach them and not question where these beliefs originally came from (even though a researcher like myself can analyse their beliefs to discover this information). It is not appropriate to attempt to infer views of science and religion for these individuals.

Chapter 12 draws together the major analysis methods described in the thesis to produce the Written Dilemma analysis system. Chapter 13 and 14 describe the application of the rounds of analysis. The results of the analysis are presented in Appendix H.

CHAPTER 12
THE FINISHED WRITTEN DILEMMA ANALYSIS SYSTEM

12.1 Introduction

This chapter describes an analysis system that draws on the preceding work to produce meaningful descriptions of individuals' approaches to science-religion dilemmas entitled the Written Dilemma analysis system.

12.2 Overview

The elements of information that are given in a description of an approach are:

> Basic category (stage within conceptual sequence);
> inferred views of science and religion, Real Relationship and Contradiction-type for each contradiction, dilemma belief.

In the final analysis system, the categories cover both expert and non-expert approaches and it is claimed that this system can be used to analyse and compare the approaches of individuals at all stages within the conceptual scheme formed for this project. In particular, the system can describe the approaches that are set out in the formal academic literature; the approaches taken by young children and the approaches taken by tertiary students.

12.2.1 The Basic Category of the Approach

As described previously the first round of analysis when examining a student's approach to a dilemma was to categorise the approach as one of the other five basic types of

approaches. In the non-Engaged approaches, no contradiction is identified and the contradiction-type analysis method is not applicable.

12.2.2 The Cognitive Stage of the Individual within the Conceptual Sequence

The second item in the description of an approach is the cognitive stage of the student within the conceptual sequence devised for this project. To speed up the analysis process, Table 16 was constructed to summarise the ways to identify the thinking that correspond to each stage.

Table 16

The Kinds of Thinking that are Characteristic of Each Stage

Stage	The Individual...
Stage 1: Juvenile	◦ Is not able to compare the accounts and accepts beliefs without question from authorities.
Stage 2: Narrative	◦ Identifies a terse or wordy contradiction and focuses on obvious story-like differences between the narratives; ◦ Has an unstructured collection of ideas about the natures of science and religion which may be inconsistent; ◦ Does not have a well-developed strategy to resolve contradictions, indicated by rationales that are vague or refer to personal circumstances
Stage 3: Unexamined Principled	◦ Identifies different contradiction types, indicating an understanding of the natures of science and religion; ◦ Consistently applies the same principles to several topics such as whether science opposes divine action; ◦ Does not refer to multiple views of science and religion; ◦ May say that some principles of science and religion are wrong; ◦ Is aware that science and religion are different in nature.
Stage 3-4	◦ As above and is aware of multiple views of either science or religion.
Stage 4: Expert-Philosophical	◦ Is aware of multiple views of science and religion; ◦ Identifies real and apparent contradictions; ◦ Describes own views of science and religion and discusses other people's views of science and religion.

12.2.3 The Contradiction-Type

For the cases in which students took Engaged approaches, the analysis process continued in the following way. Each apparent contradiction raised by the student was categorised as wordy, terse or standard. Standard contradiction-types were further identified using the

list of standard contradiction-types for students and experts (divine creation, discrete theistic action, theistic action, miraculous action and Biblical data). The identification of a contradiction as one of the specified types was possible for all cases because the categories of contradiction-types had been devised to cover the range of contradictions that students and experts raised.

12.2.4 The Real Relationship

The analysis method that applied to students' views of the relationship is given in Chapter 8.5.1.2. To summarise the steps thus far, the analysis codes for this part of the analysis process are given in Table 17.

Table 17

Categories for the Contradictions Identified by Students

Approach	**Stage within the Conceptual Sequence**	**Contradiction Type: Terse, Wordy or Standard**	**Standard contradiction-types**	**Relationship: Real Contradiction or Compatible**
Non-Engaged	1, 2, 3, or 4	(No contradiction identified)		
Engaged	2, 3 or 4	Terse		
		Wordy with Biblical data		
		Standard	Divine creation Theistic action Miraculous action Biblical data	Real contradiction (refers to one view only); Real contradiction (refers to multiple views); Compatible (refers to one view only); Apparent-only (refers to multiple views).

Once the contradictions were coded in this way, the information that could be inferred from each perceived contradiction was presented in the form "science asserts..." and "religion asserts..." In this way, the principles within the student's views of science and religion were compiled for each dilemma.

12.2.5 Beliefs

The method for analysing individuals' beliefs was set out in Chapter 8.5.1.5. The decision about what to believe (previously called the "action") was used to cross check the dilemma belief in the revised system.

12.2.6 Views about Science and Religion

Students' inferred views of science and religion are given at the beginning of the description of the approach, but when the transcripts were analysed, they were the last items of information that were discovered.

The labels for students' views are convenient to use in the approach description because they are relatively short, for example: "materialism" and "determinism". When discussing the results of the analysis process it was found to also be valuable to discuss the leading principles that students held.

Leading principles are ones that are central in terms of shaping an individual's views. For example, if it is shown that a student believes that science opposes all kinds of divine action then it seems reasonable to say that the student's view resembles Scientific Materialism. These leading principles are also the ones that differentiate between major views. For example, if a student believes that science does not oppose the possibility of divine creation then the student's view is not Scientific Materialism but may be Scientific Determinism. Another example of a leading principle is the belief that the Bible was written to be read literally. This belief is particularly relevant when forming responses to

many science-religion dilemmas. The idea of leading principles was developed for this project as a way to provide meaningful descriptions of students' views in those cases in which students did not express clear standpoints on all of the issues in the dilemmas.

Finding that students believe that science or religion includes one or other of these leading principles meant that it was possible to say that the students' views resembled the corresponding Standard view in this important respect. It also meant that it was possible to say that the student did not support another view that does not have this leading principle.

12.3 Other Items of Information Found Via Analysis

Chapter 13 presents the results that were found when the Written Dilemma analysis system was applied. Chapter 14 present findings regarding a number of other characteristics of students' thinking found during the course of the research. These are:

- Students' Free Choice approaches (drawn from students self-descriptions of how they ordinarily responded to science-religion dilemmas);
- The rationales that students gave for their decisions about what to believe given an apparent contradiction. Students' rationales were insightful but individualistic which is why they were not included in the typology of written dilemma approaches.

12.4 Chapter Conclusion

In this chapter the major analysis methods described in chapters 7-11 were drawn together to show that when they are used in combination, they produce meaningful descriptions of individuals' approaches. The first stage of the analysis looks at the basic type of approach taken by the student and in particular, whether the student chooses to identify apparent contradictions between the paragraphs in the written dilemma.

A significant part of the written dilemma analysis system infers students' principles of science and religion from the contradictions that they identify. Thus if a student said that there is a real contradiction between science and religion on the question of whether God created the universe, then clearly this student believes that science asserts that the universe was not created by God. In this way information about each student's views about science and religion is drawn from the transcripts by analysing each student's responses to each written dilemma in turn.

In addition, by analysing the consistency with students perceive particular types of contradictions, together with other characteristics of their thinking, the analysis then reveals information about students' cognitive stages within the conceptual sequence. The results produced by this analysis system are presented in Chapter 13.

PART 5: APPLYING THE ANALYSIS METHODS IN THE FIRST STUDY

CHAPTER 13

APPLYING THE WRITTEN DILEMMA ANALYSIS SYSTEM

13.1 Introduction

This chapter and the next chapter set out the results that were obtained when the analysis methods devised here were applied to the first set of 20 interviews

This chapter describes the application of the written dilemma analysis system which consists of a series of methods. The analysis system was used to categorise students' approaches into the five-fold basic typology; to describe students' stages in the sequence; to label the contradictions they identified using the contradiction-type method of analysis and to probe students' beliefs regarding the three dilemmas. This is the information that it has been decided will be given in a description of an individual's approach.

In the presentation and discussion of the results, a qualitative and quantitative paradigm has been adopted, showing both the range of viewpoints and the number of students within the group who expressed selected viewpoints. The category system developed for this project leads naturally to the generation of quantitative descriptions, which in turn are insightful because they reveal the distribution of responses made by the group and whether any one response was particularly common. The use of a triangulation of analysis methodologies also leads to a greater assurance of content validity.

Additional processes that were carried out to test content validity are described during the chapter. In overview, internal validity is claimed on the basis that each participant makes comments that identify him or her with a particular category in the analysis table on a number of occasions at different points in the interview. Internal validity was also enhanced by my prolonged engagement and persistent observation of the transcripts. Peer review and debriefing was a further process that was applied on several occasions to provide an independent assessment of the coding and categorisation systems.

An important finding from the analysis was that none of the 20 students believed that science permits theistic action. Eighteen students raised the issue of theistic action directly and the other two students indicated that science opposes all kinds of Divine Action. Another notable finding was that none of the students demonstrated an awareness of multiple views of science. In contrast, five students showed an awareness that there are different views about how to interpret Biblical accounts.

13.2 Written Dilemmas Approaches

The Written Dilemma typology was developed to describe the ways in which students responded to the three written dilemmas that were presented to them in the interview.

The students' comments regarding the written dilemmas were analysed according to the analysis rules set out in Chapter 7.6. A summary of the results is given in Table 18.

Table 18

Overview of Results of Written Dilemma approach Analysis

Dilemma Approach	**Number of Times this Approach was Taken By the Students in the Sample**
Engaged	57
Disengaged with undetermined belief	2
Disengaged with fixed belief	1
Unconnected	0
Juvenile	0
Total	60

During the interviews, each student studied three topics, making a total of 60 case studies. Students were asked to identify apparent contradictions between the scientific and religious paragraphs. The results show that in 57 out of these 60 cases, the student took an Engaged approach. This is in comparison with the finding that half of the group indicated that if they had a free choice about how to respond, they would not ordinarily reflect on the dilemma.

In five of these cases, students made transitional comments indicating that this was the first time they had considered the possibility that there were contradictions between the accounts.

13.3 Students' Cognitive Stages within the Conceptual Sequence

To discover students' cognitive stages in the conceptual sequence, the transcripts were analysed using the criteria listed in Table 16.

13.3.1 Summary of Results

The results of the analysis are shown in Table 19 below.

Table 19

Students' Cognitive Stages within the Conceptual Sequence

MU3	2
MU4	2
MU5	3-4
MU6	2
MU7	2
MU8	2
MU9	3-4
MU17	3
MU20	2
MU21	3

MU27	2
MU28	2
MU29	3-4
MU30	3-4
MU32	2
MU33	3
MU34	2
MU35	3
MU36	3
MU37	3

13.3.2 Discussion of Results

13.3.2.1 Awareness of Multiple views of Science and Religion

When individuals indicate that they have reflected on the possibility of other views of science and religion, this is said to be the kind of thinking that is carried out by someone at the most advanced stage in the conceptual sequence.

Testing for an awareness of multiple views was relatively straightforward and produced results that are relatively conclusive. Of the 20 students in the sample, four referred to multiple views of science or religion. On examination, in all these cases, it was the nature of religion that was discussed, for example:

> "The Bible says that the world was created in six days. Science says it was molecules. It contradicts if you think of the Bible literally. But if it's not literal it's OK" (MU29 Creation).
>
> "The seven days may not have been seven days so it may be OK with the Big Bang theory" (MU5 creation).
>
> "I think you can combine them somehow ... you have to look at religion in a different way knowing that there are a lot of scientific things out there" (MU30 creation).

The student, MU29 also discussed the assertion of theistic action, saying that in his view, religion asserts that God is passive, but others might hold another view.

> "It depends on who you ask and their faith. People who want to believe in the power of prayer perceive a contradiction. I don't perceive a contradiction because I don't believe in prayer" (MU29)

The nature of science was described in terms of one view by each of the four students. These findings seem to imply that students may progress to stage 4 unevenly, reflecting on the nature of religion before they reflect on the nature of science. On this basis the stage of the students was deemed to be 3-4.

13.3.2.2 Stages 2 and 3

A student who identifies apparent contradictions, or explains why there are none, is said to be at stage 2 or above in the conceptual scheme.

The key test that distinguishes thinking at stage 3 from thinking at stage 2 is that the student has a consistent and well developed ideas about the natures of science and religion and draws on these understandings to identify contradiction-type contradictions. The tests for this stage of thinking were set out in Table 16.

In contrast, students at stage 2 have fewer established principles of science and religion. They describe contradictions that are "terse" or "wordy" and they may be inconsistent from one topic to another.

On this basis, 10 students were judged to be at stage 2 while 6 were said to be at stage 3.

13.3.3 Support for Findings

Current theories of cognitive development indicate that students advance from stage to stage as they mature. Each stage does not correspond to a particular age, since some students advance faster than others but in general, older students are often more advanced than younger students (King & Kitchener, 1994; Perry, 1988; Rest 1986).

On this basis, a comparison was made between the age of each of the students in this sample, and his or her inferred stage within the sequence devised for this project. The correspondence between age and stage was noticeable.

Most students were aged 19-23 and the average age was 20.5. There was one mature student (age 33). This student was one of those deemed to be at a more advanced stage (stage 3-4). Another student judged to be at this stage were also older than 23. A third student was one of only two students who said they had formally studied the relationship between science and religion. I suggest this is another factor that affects the rate of cognitive progression.

13.3.4 Why Some Students Might Progress More Slowly than Others

Gardner proposed that existentialist thinking requires a particular kind of intelligence (Gardner, 1999). It seems reasonable to suppose that students who spend very little time thinking about these issues would advance more slowly than those who consider the topics more.

A conscious decision not to reflect on these matters would surely slow the rate of progress. About half of the students in the sample indicated that at various times they consciously disengaged from reflecting on the topics. During these periods students would surely not be progressing as rapidly if at all in this area of cognitive development.

13.3.5 Changes to Students' Views during the Interview

In chapter 6, it was observed that during the interview some students changed the way in which they approached science-religion dilemmas. The transition by some students from a Free Choice Disengaged to a Written Dilemma Engaged approach has already been mentioned.

Another observed change was that when they read the written dilemmas, some students evidently became aware of approaches that they had not previously considered. It was clear from their comments, for example, that at least two students had not previously considered combining the accounts:

> "I haven't thought about them together like this before. I've always thought of religion and science and they're totally different. I've never thought of God making science" (MU6);

> "Either something greater made us or evolution made us from mud. It's too hard and you can't bring them together. I've not thought about this before. Now I think they are linked. I used to think they were separate" (MU8).

The significance of these findings is as follows. Firstly, these findings seem to support the argument that the range of approaches available to students is limited by a lack of awareness of alternatives.

Secondly, the dilemmas and questions used in this interview appear to be an effective way to introduce students to the idea that there are alternative approaches. I suggest that this is at least in part because of the nature of the interview. In the dilemma section, the paragraphs of text draw attention to the underlying themes that are important in science-

religion dilemmas. Indeed it could be said that the dilemmas are an example of the Kohlberg-Blatt method of motivating students to formulate more advanced cognitive positions (Blatt & Kohlberg, 1975). Students are asked questions that encourage them to examine their viewpoints and to draw on new ideas. Students appeared to enjoy reading the written paragraphs and many said that the exposure to new ways of thinking about the dilemmas was welcome. This fits well with a finding by Rest (1986) that senior school students preferred answers to moral dilemmas that were expressed by students who were at higher rather than lower stages of moral development than they were, whether they fully understood these answers or not. Rest suggests that students have some intuitive sense of the greater adequacy of the higher stages.

Thirdly the stages that are specified for students in Table 33 are based on an analysis of how students thought about the dilemma topics when they had access to the ideas presented in the written dilemmas. It seems likely that this scaffolding enables some students to think in ways that are associated with a more advanced stage.

13.4 The Contradiction-type Method of Analysis

13.4.1 Introduction

This section describes the results of the Contradiction type analysis method which was designed to categorise the types of contradictions that students perceived and to infer information about students' views of science and religion.

13.4.2 Contradiction-Types

13.4.2.1 Results

The transcripts were analysed to discover what types of contradictions students identified in the three written dilemmas. Appendix F presents quotations from the transcripts and categorisations to illustrate the process.

Table 20 sets out the basic approach, the contradiction type, and the real relationship for each apparent contradiction. The numbers in brackets indicate the number of occasions on which a student identified the same standard contradiction-type more than once. In Table 20 an asterisk marks the one instance of a student, MU20, drawing on principles that are contradictory.

Table 20

Basic Approach and Contradiction-Types

Student	Basic Approach and Contradiction-Type
MU3	Disengaged approach with undetermined belief: No contradiction identified
	Engaged: Real contradiction on theistic action
	Engaged: Real Contradiction on theistic action (2)
MU4	Engaged: Real Contradiction on divine creation
	Engaged: Real Contradiction (wordy with Biblical data)
	Disengaged approach with fixed belief: No contradiction identified
MU5	Engaged: Compatible on Biblical data (refers to multiple views)
	Engaged: Compatible on divine creation (2)
	Engaged: Real Contradiction on theistic action (2)
MU6	Engaged: Real Contradiction (terse)
	Engaged: Real Contradiction on Biblical data
	Engaged: Real Contradiction on theistic action
MU7	Engaged: Real Contradiction on Biblical data
	Engaged: Real Contradiction (wordy with Biblical data)
	Engaged: Real Contradiction on theistic action
MU8	Engaged: Real Contradiction (terse)
	Engaged: Real Contradiction (wordy with Biblical data)
	Engaged: Real Contradiction on theistic action
MU9	Engaged: Apparent-only contradiction on divine creation (2) (refers to multiple views)
	Engaged: Apparent-only contradiction on theistic action (refers to multiple views)
	Disengaged approach with undetermined belief: No contradiction identified
MU17	Engaged: Real Contradiction on Biblical data
	Engaged: Real Contradiction on divine creation (2)
	Engaged: Real Contradiction on theistic action
MU20	Engaged: Real Contradiction on divine creation
	Engaged: Compatible on divine creation*
	Engaged: Real Contradiction on theistic action
	Engaged: Real Contradiction (wordy with Biblical data)
MU21	Engaged: Real Contradiction on divine creation (3)
	Engaged: Real Contradiction on Biblical data
	Engaged: Real Contradiction on theistic action

MU27	Engaged: Real Contradiction on divine creation Engaged: Real Contradiction on theistic action Engaged: Real Contradiction (terse)
MU28	Engaged: Real Contradiction (terse) Engaged: Real Standard Contradiction on divine creation Engaged: Real Contradiction on theistic action
MU29	Engaged: Apparent-only contradiction on Biblical data (2) (refers to multiple views) Engaged: Compatible on divine creation (2) Engaged: Apparent-only contradiction on theistic action (refers to multiple views)
MU30	Engaged: Compatible on divine creation (2) Engaged: Compatible on Biblical data (refers to multiple views) (2) Engaged: Real Contradiction on theistic action
MU32	Engaged: Real Contradiction (terse) Engaged: Real Contradiction on theistic action Engaged: Real Contradiction (wordy with Biblical data)
MU33	Engaged: Real Contradiction on Biblical data Engaged: Real Contradiction on divine creation Engaged: Real Contradiction on theistic action
MU34	Engaged: Real Contradiction (terse) (2) Engaged: Real Contradiction on divine creation (2) Engaged: Real Contradiction on miraculous action
MU35	Engaged: Real Contradiction on divine creation (2) Engaged: Compatible on Biblical data Engaged: Real Contradiction on theistic action
MU36	Engaged: Real Contradiction on divine creation Engaged: Real Contradiction on Biblical data Engaged: Real Contradiction on theistic action (2)
MU37	Engaged: Real Contradiction on divine creation Engaged: Real Contradiction on Biblical data Engaged: Real Contradiction on theistic action (2)

13.4.2.2 Self-Consistency across the Three Dilemmas

Students' responses were analysed to discover how frequently they repeated each principle and whether there instances of self-contradictions when they responded to the three dilemmas.

The results in Table 20 (above) show that 13 students identified the same type of contradiction more than once across the three dilemmas. In other words, in regard to the principles of science and religion relating to Biblical data, theistic action and divine creation, 13 of the 20 students demonstrated that they drew on the same principles of science and religion on at least one occasion for at least one of these issues.

Table 20 indicates that one student contradicted herself during the written dilemma section of the interview. This student, MU20, indicated on one occasion that science opposes divine creation but on another occasion, said that it does not.

For the other 19 students, the principles that they were inferred to hold were self-consistent. A measure of students' consistency was obtained by counting how many times each student identified a given apparent contradiction as they discussed the three written dilemmas.

13.4.2.3 Applicability

When the contradictions identified by students were analysed, it was found that there were sufficient categories to describe all the types of contradictions that students identified. Table 21 presents a summary of all the contradiction-types identified by the group of students.

Table 21

Results Showing All Contradiction-types Identified by Students

Approach	Terse, Wordy or Standard	Standard Contradiction-Types	Relationship	No. of Cases
Juvenile				0
Unconnected				0
Disengaged with undetermined belief	(None identified)	-	-	2
Disengaged with fixed belief	(None identified)	-	-	1
Engaged	Terse	-	Real (refers to one view only)	6
Engaged	Wordy with Biblical data	-	Real (refers to one view only)	5
Engaged	Standard	Divine creation	Real (refers to one view only)	16
		Divine creation	Compatible (refers to one view only)	7
		Divine creation	Apparent-only (refers to multiple views)	2
	Standard	Theistic action	Real (refers to one view only)	15
		Theistic action	Compatible (refers to one view only)	0
		Theistic action	Compatible; (refers to multiple views)	2
	Standard	Miraculous action	Real (refers to one view only)	1
	Standard	Biblical data	Real (refers to one view only)	7
			Compatible (refers to one view only)	1
			Apparent-only (refers to multiple views)	5

13.4.2.4 Empty Categories

As Table 21 shows, there were no examples of Juvenile or Unconnected approaches. This is within expectations because the students in the sample were relatively mature and because they were specifically asked to compare the accounts during the Dilemma section of the interview. If young children were interviewed, it is argued that examples of the Juvenile approach would be found.

Another viewpoint that was not found is the view that science and religion are compatible on theistic action.

Thirdly, none of the students in this sample who identified a real contradiction and then said that another person might disagree that that is a real contradiction. The type of individual who might make such a comment would be a Biblical literalist who is aware that some people remove the apparent contradictions by reformulating religion.

13.4.3 Inferred Principles of Science and Religion

In the analysis system, the next step is to rewrite each apparent contradiction as a scientific assertion and a religious assertion appertaining to a given dilemma. At this stage, the information is dilemma-specific. For example, if a student identifies a contradiction regarding theistic action on the topic of prayer, then it is deduced that this student believes that religion asserts theistic action and science opposes it in the context of the prayer dilemma.

The next round of analysis explores the possibility that the student holds these assertions to be generally true and then tests whether this is the case. In this way, general principles relating to each student's views of science and religion are "inferred" from the specific examples of how the student responds to the three written dilemmas. When inferring this information, attention is paid to the possibility that the student has not yet established consistent ideas about science and religion, in which case the inferred principles may not be self-consistent.

13.4.3.1 Leading Principles

As discussed in Chapter 12.2.6, some principles are central in shaping an individual's views about science and religion. Two important issues in this regard are whether the Bible should be interpreted literally and whether science opposes divine action.

Drawing on the results set out in Table 20 (given previously), Table 22 (below) presents a summary of the inferred principles that students held regarding what religion says about the correct interpretation of the Bible, and what science says about the possibility of divine action. The students' inferred principles of religion relating to theistic action are also included because they are a point of discussion in the following section. In Table 22 asterisks identify the inferred principles of science and religion that are competing in each given topic.

Table 22

Students' Inferred Principles of Science and Religion on Key Issues

Inferred Principles of Science and Whether Science Opposes Divine Action	
Science opposes every kind of divine action	MU3, MU4, MU6, MU7, MU8, MU17, MU20*, MU21, MU27, MU28, MU33, MU34, MU35, MU36, MU37
Science opposes theistic action but does not oppose divine creation	MU5, MU9, MU20*, MU29, MU30
Science opposes theistic action (other issues are not addressed)	MU32

Inferred Principles of Religion and whether Religion asserts Theistic Action	
Religion asserts theistic action	MU3, MU4, MU5, MU6, MU7, MU8, MU17, MU20, MU21, MU27, MU28, MU30, MU32, MU33, MU34, MU35, MU36, MU37
Religion does not assert theistic action	MU9, MU29

Inferred Principles of Religion and whether the Bible is Intended to be Read Literally or Allegorically regarding miracles and data	
Religion asserts that the Bible is intended to be read literally	MU4, MU6, MU7, MU8, MU17, MU21, MU28, MU32, MU33, MU34, MU36, MU37
Religion asserts that the Bible is intended to be reformulated	MU5, MU9, MU29, MU30, MU35
The student does not say what religion says about how the Bible should be interpreted	MU3, MU20, MU27

13.4.4 Validity and Implications of these Findings

13.4.4.1 Testing the Validity of the Inferred Views

Given that in this analysis method, generalisations are inferred from specific instances, it is important to find other ways to examine students' views and to test whether each student does indeed hold the inferred principles to be generally true. This was done by reading each transcript and marking idea units that referred to the principles that the student was inferred to hold. The results of this analysis are presented in Section 13.4.6.4. In the following paragraphs, when discussing the results of each round of analysis, selected quotations of this kind are given to supplement the quantitative and interpretive discussion. As the examples show, there are many occasions on which students made comments that supported the inferred principles. The clarity of some students' descriptions of perceived contradictions also implies that these students have well-established views and are focussed on the issues being considered. This also will be illustrated with examples. On relatively fewer occasions students were found to be inconsistent or vague, indicating that their views were not well established.

13.4.4.2 Science Opposes All Kinds of Divine Action

Fifteen students were inferred to believe that science opposes the possibility of any kind of divine action. Examples of the contradictions that led to this inference are:

> "According to science, the universe is meaningless. It's just a bunch of atoms bumping into each other and it doesn't matter whether we exist or not" (MU21);
>
> "They contradict. Religion says there was a greater being. Science says there wasn't. I sort of believe the world came about scientifically and all that stuff" (MU17).

One student, MU20 was inconsistent on this question saying at one point that science does oppose all kinds of divine action, but at another point that science does not oppose divine creation.

Having assumed that science opposes the possibility of any kind of divine action, some students then indicated that science was wrong to make this assertion. This is in contrast with the Assimilationists' approach which is to say that science permits discrete theistic action. In the following quotation, MU21 rejects the allegedly scientific claim that there is no divine plan:

> "I've basically rejected what I've been taught in science. Scientists are too narrow-minded. Science is wrong. My own theory is the universe is meaningful" (MU21).

In a similar way, MU34 perceived a real contradiction over how the universe began, and then rejected what she saw as the scientific view:

> "They're different views that contradict. I don't think everything could be this perfect unless it was created by God" (MU34 Creation).

13.4.4.3 Science Opposes Theistic Action

An important inference within the results presented in Table 22 is that none of the 20 students in the group believed that science permits theistic action. Eighteen students identified a contradiction specifically on this issue. The other two students (MU9 and MU34) did not raise theistic action as a separate issue but did indicate that science opposes the idea of God's existence and hence all forms of divine action. The implication of this finding is that all the students in this group believed that it scientifically untenable to say that God can influence events in the universe in an ongoing way. Contrast this with the approach of Assimilation, in which it is said that science permits discrete theistic action. This is how many religious scientists argue that God can influence events in the universe today, and can respond to prayer.

The following quotations are examples of students identifying contradictions regarding theistic action:

> "There's a will that directs things versus things just happen" (MU3);

> "The world has its own formula versus praying makes a difference" (MU5);
>
> "One says God responds to prayers and science says He doesn't" (MU21);
>
> "There is (a contradiction) because one says God is at work and the other says it's just the molecules" (MU37).

13.4.4.4 Deism

Two students presented the view that science and religion were in harmony on the issue of theistic action. These students saw religion as equivalent to Deism, which then did not produce a contradiction in their minds on this issue:

> "It's not a contradiction if God is just watching" (MU29).
>
> "It depends on who you ask and their faith. People who want to believe in the power of prayer perceive a contradiction. I don't perceive a contradiction because I don't believe in prayer" (MU9).

Thus these students believed that science opposes theistic action and that religion does not assert it. This is how MU29 described his view of religion:

> "God may not have created Adam and Eve but he may have been the one to have initiated the whole evolution thing in the beginning and is now watching it through the years. That's becoming the current religious view" (MU29).

13.4.4.5 Inferred Principles of Religion

The analysis of students' inferred leading principles set out in Table 22 indicates that 11 of the 20 students believed that religion intends that references to events and data in the Bible should be interpreted literally, even when this results in a contradiction with mainstream science. The following are examples of this contradiction-type:

> "The contradiction is about whether humans started with Adam and Eve or whether humans evolved" (MU6);
>
> "They contradict. The religious view says there was Adam and Eve and the science view says life evolved" (MU7).

Most students did not accept the Biblical account of how human life began. In this example, MU7 rejects what she describes as the religious view, saying science has proved it wrong:

> "I've seen a lot of evidence for the scientific version and not much for the religious viewpoint. I'm an evidence girl" (MU7).

When students reject Biblical data that is contradicted by mainstream science, they are, from their points of view, rejecting claims made by religion. This is in contrast to the approach taken by the religious scientists who argue that religion did not require a literal interpretation.

13.4.5 Students' Inferred Views of Science and Religion

13.4.5.1 Results

The next step in the analysis process was to compare students' inferred views with the Standard views of science and religion. In the preceding section, a match between two students' inferred views and Deism was suggested. This section describes a more systematic attempt to match students' inferred views with those given in Chapter 10, Table 12 and Table 14. The process used was to seek a match between the scientific (or religious) principles that students were inferred to hold and one of the given views.

In order to indicate how well each student's thinking matches with the Standard views, the student is given a score for the number of contradictions that the student identifies that agree with a particular combination of views. For the example given above, the score is 4

since this student identified four contradictions that would be perceived by a holder of this particular combination of views. The results are given in Table 23.

Table 23

Students' Views as Standard Views of Science and Religion

	View of religion	**View of Science**	**Compatibility**
MU4	Biblical Literalism	Scientific Materialism	2
MU17	Biblical Literalism	Scientific Materialism	4
MU21	Biblical Literalism	Scientific Materialism	5
MU27	Theism	Scientific Materialism	2
MU33	Biblical Literalism	Scientific Materialism	3
MU34	Theism	Scientific Materialism	3
MU36	Biblical Literalism	Scientific Materialism	6
MU37	Biblical Literalism	Scientific Materialism	4
MU20	Biblical Literalism	Scientific Materialism Scientific Determinism	Inconsistent
MU35	Reformulated Theism	Scientific Materialism	3
MU9	Deism	Scientific Determinacy	3
MU29	Deism	Scientific Determinacy	3
MU5	Reformulated Theism	Scientific Determinacy	5
MU30	Reformulated Theism	Scientific Determinacy	5
MU3	Theism	Scientific Materialism/Determinacy	2
MU6	Biblical Literalism	Scientific Materialism/Determinacy	2
MU7	Biblical Literalism	Scientific Materialism/Determinacy	2
MU32	Biblical Literalism	Scientific Materialism/Determinacy	2
MU8	Biblical Literalism	Scientific Materialism/Determinacy	3
MU28	Theism	Scientific Materialism	2

The most common combination of inferred views according the results in Table 23 was science resembles Scientific Materialism and religion resembles Biblical Literalism. Eight students held this combination of views.

A student's inferred view of science was said to resemble Scientific Materialism if the student identified one or more contradictions to the effect that science opposes all kinds of divine action including divine creation. A student's inferred view of religion was said to resemble Biblical Literalism if the student identified contradictions relating to Biblical events and data.

13.4.6 Testing the Inferred Views of Science and Religion

Four ways were identified to test the validity of the inferred views of science and religion.

13.4.6.1 Consistency Regarding Inferred Views

One measure of a student's consistency, which also tests for content validity, is to ask whether all the contradictions that the student identifies are consistent with one pair of inferred views of science and religion. The results in Table 23 indicate that students were consistent in this regard in the cases of all but one student.

There were three additional sources of information about students' views of science and religion. These were also used to test the consistency of the students' views and to crosscheck the results produced by the contradiction-type analysis method.

13.4.6.2 The Stated Relationship between Science and Religion

At the beginning of the interview, students were asked to talk about the relationship in general between science and religion. These comments were used in a relatively simple test of the students' consistency. The aim was to see whether the students who described the relationship as one of contradictions did indeed perceive contradictions to exist when they studied the dilemmas.

Looking at the students' descriptions of the relationship, given in Table 7 on p. 96, 13 students described the relationship as one that produces contradictions. These students are MU4, MU6, MU7, MU17, MU20, MU21, MU27, MU28, MU32, MU33, MU35, MU36 and MU37. It is also the case that these students all identified real contradictions in the dilemma topics. Looking at Table 23, these students are inferred to hold views of science and religion that are competing. There is thus a good correlation between the two sections of the interview in each of these cases.

Referring again to the views of the relationship, two students MU8 and MU34 said initially that they were unaware of contradictions between science and religion on the basis that they had not considered them simultaneously prior to the interview, as illustrated by this comment by MU34:

> "I guess because I haven't done a lot of science studies, I haven't been forced to question everything I believe... and I've been able to say, yeah, there's no contradiction still for me" (MU34).

In the dilemma section these students perceived there to be contradictions. The differences between their responses in the two sections can be explained by the clear changes they made to their approaches.

The student MU3 declined to describe the relationship between science and religion at the beginning of the interview with the result that a comparison cannot easily be made.

Three students MU9, MU29 and MU30 described the relationship between science and religion using such terms as, "They needn't contradict". Looking at the results of the contradiction-type analysis method, it can be seen that these students did not perceive there to be contradictions on the topic of creation nor on the topic of how human life began, nor, for two of the students, on the topic of prayer.

The following quotations indicate their views that there are no contradictions in the creation and life dilemmas:

> "God may not have created Adam and Eve but he may have been the one to have initiated the whole evolution thing in the beginning and is now watching it through the years. That's becoming the current religious view" (MU29).

> "There doesn't need to be a contradiction. It's possible that scientific laws and theories could have been created by some God" (MU9).

> "I don't believe you have to have one or the other. God made evolution or God allowed us to evolve" (MU30).

These students' inferred views of science and religion were Determinacy and Deism respectively, which are compatible views. The quotations given above are good illustrations of this approach. Thus the students' stated views of the relationship are in agreement with the inference that that these students held views of science and religion that are compatible.

The last example to be discussed here is that of MU5. As she discussed the dilemmas, this student indicated that religion had been proved wrong regarding the claim that God acts theistically. On the topics of creation and how life began the student expressed the view that science and religion are compatible:

> "I think there was an overall plan and things happened in the scientific way. I'm trying to resolve the two together. I want to hold onto both" (MU5).

The views of science and religion that she was inferred to hold were Reformulated Theism and Scientific Determinacy, which produce contradictions on the issue of theistic action but not creation or Biblical data. This inference of her views fits well with her description of the relationship at the beginning of the interview. The student said that science and religion clash but that they can be made to fit together.

Thus in all but three cases, students' descriptions of the relationship are compatible with their inferred views of science and religion. In those three exceptional cases, the reasons why discrepancies arose can be explained.

13.4.6.3 Students' Explicit Views about Science and Religion

In the first section of the interview, students were asked, "what is science?" and "what is religion?" Table 24 presents a summary of the findings for all the students.

Table 24

Ways Students Describe the Natures of Science and Religion

Nature of Science; Nature of Religion	**Identities of Students Who Hold This View**	**Number of Students Who Hold This View**
Facts with evidence versus beliefs/ideas	MU6, MU7, MU8, MU17, MU21, MU27, MU28, MU32, MU34, MU35, MU36, MU37	12
Laws versus beliefs	MU9, MU30	2
How we are here and Why we are here	MU20, MU29, MU33	3
Equivalent explanations	MU3, MU5	2
What we can explain versus something to fill the gaps	MU4	1

Students' responses to these questions were studied in an attempt to discover whether they correlated with the views that students were inferred to hold. Looking at the results in Table 24, it cannot be said conclusively that students saw science as scientific materialism, scientific determinacy or any other view described in the formal literature because students did not describe the natures of science and religion in these terms. The results do confirm that a majority of students regard science as having a proven, law like and factual nature which is consistent with the views of materialism and determinacy.

The findings from this analysis were thus consistent with the findings of the Contradiction-type analysis but were less detailed and less precise. The imprecision arises because students' comments consist of lay terms which do not correspond exactly to the terminology used in the formal literature. One of the advantages with the contradiction-

type method is that it applies to the part of the transcripts where the use of lay terms was not a serious impediment to the analysis process. When science and religion are said to contradict on a certain claim, then this would seem to clearly indicate that the student believes that one field makes this claim and the other field opposes it.

13.4.6.4 Additional References to Principles of Science and Religion

During the interview students gave ah-hoc comments about the natures of science and religion, for example when giving rationales for their decisions. These rationales and generalisations were used to verify the findings produced by the contradiction-type analysis method. For example the student MU5 confirmed the inference that she believed that the Bible need not be read literally when she said: "I think maybe for God six days is like six billion years".

The transcripts were analysed to identify idea units (phrases or sentences) in which the student described the nature of science or religion. Incomplete ideas were accepted. Each transcript was scored by counting how many idea units supported the student's inferred views of science and religion and how many contradicted the inferred views.

The results indicated good support for the views inferred via the contradiction-type method of analysis for most students. An important finding was that there was only one example of an idea unit that was incompatible with the inferred views of science and religion by the contradiction-type analysis method. The method is not completely independent, however, as students' rationales for their decisions were sometimes intertwined with their descriptions of contradictions. The results are given in Table 25.

Table 25

Number of Comments that Supported or Contradicted Inferred Views of Science and Religion

Student	Support for Inferred View of Religion	Support for Inferred View of Science
MU3	5	6
MU4	4	8
MU5	7	8
MU6	7	7
MU7	5	4
MU8	7	6
MU9	5	3
MU17	5	6
MU20	5	2 (-1)
MU21	4	4

Student	Support for Inferred View of Religion	Support for Inferred View of Science
MU27	6	4
MU28	4	2
MU29	5	3
MU30	4	9
MU32	7	6
MU33	6	8
MU34	5	8
MU35	3	2
MU36	6	7
MU37	4	4

13.5 Students' Beliefs Regarding the Written Dilemmas

13.5.1 A Results

Students' beliefs were categorised as science only, Religion only, Combined, Neither or Undecided. The rules of analysis for students' beliefs were given in Chapter 8.5.1.5.

Table 26 sets out each student's beliefs for each of the three written dilemmas. The consistency score is obtained by adding one each time a student arrives at a similar belief from one dilemma to the next. The highest score is 2.

Table 26

Students' Dilemma Beliefs

	Topic 1: Creation	**Topic 2: Life**	**Topic 3: Prayer**	**Consistency**
MU3	Combined	Undecided	Undecided	1
MU4	Science only	Science only	Science only	2
MU5	Combined	Combined	Undecided	1
MU6	Undecided	Undecided	Undecided	2
MU7	Science only	Science only	Science only	2
MU8	Undecided	Undecided	Undecided	2
MU9	Combined	Undecided	Science only	0
MU17	Science only	Science only	Science only	2
MU20	Science only	Combined	Undecided	0
MU21	Combined	Undecided	Undecided	1
MU27	Undecided	Science only	Undecided	1
MU28	Undecided	Undecided	Undecided	1
MU29	Combined	Combined	Science only	1
MU30	Combined	Combined	Undecided	1
MU32	Undecided	Neither account	Undecided	1
MU33	Religion only	Religion only	Religion only	2
MU34	Religion only	Religion only	Religion only	2
MU35	Science only	Undecided	Undecided	1
MU36	Combined	Science only	Science only	1
MU37	Religion only	Religion only	Religion only	2

13.5.2 Discussion

Looking at the results in Table 26, the total number of case studies for the group as a whole is 60. The most commonly given response according to this system of analysis was that the student had not formed a belief on the topic (23 cases of Undecided). The next most common response was to accept information from science only (16 cases) and then

to accept information from both sources (11 cases). In nine cases, students supported a belief drawn from the religious narrative only.

With regard to consistency, eight students arrived at the same type of belief for all three topics; ten reached consistent beliefs on two topics and only two indicated different types of beliefs for each topic.

13.6 Chapter Conclusion

The transcripts were analysed using the analysis system that had been designed, and the information found in this way was presented and discussed. The rounds of analysis revealed several interesting characteristics of students' thinking such as their general belief that science opposes theistic action. The implications of these findings are discussed further in Chapter 16.

It is claimed that the information provided by this analysis system can be used to give meaningful descriptions of the approaches that individuals take to science-religion dilemmas. Appendix H presents these descriptions for each written dilemma for each student. The elements are presented in a table to save repeating information such as the stage of the student with each dilemma approach.

CHAPTER 14
RESULTS FROM ADDITIONAL ANALYSIS

14.1 Introduction

Chapter 13 described the results of methods of analysis devised to obtain meaningful descriptions of students' dilemma approaches. This chapter describes addition results that were obtained during the study.

14.2 Students' Free Choice Approaches

14.2.1 Results

A Free Choice approach refers to the way that a student responds to a science-religion dilemma when he or she can choose freely whether to engage in reflecting on the dilemma. The categories of Free Choice approaches were drawn from students' self-descriptions of how they generally respond to science-religion dilemmas when they encounter them outside the interview situation. Table 27 presents the results of the analysis to categorise students' self-described approaches using the five-fold typology of Free Choice approaches.

Table 27

Students' Free Choice approaches

Free Choice Approach	**Students**	
Juvenile		0
Unconnected	MU8, MU34	2
Free Choice Disengaged with undetermined belief	MU3, MU6, MU9	3
Free Choice Disengaged with fixed belief	MU4, MU7, MU17, MU36, MU33	5
Engaged	MU5, MU20, MU21, MU30, MU32, MU35, MU27, MU28, MU29, MU37	10
Total		20

14.2.2 Discussion

The results in Table 18 show that half the students in the sample usually engaged in reflecting on science-religion dilemmas when they encountered them. Eight students chose to avoid reflecting on these kinds of dilemmas either because they had already determined what to believe or because they are not seeking answers. Two students had not previously held scientific and religious information in attitudinal juxtaposition before the interview. In Table 27 the category of Juvenile approaches is the only empty category.

14.2.3 Cross Checking

There were five students who were categorised as taking a Free Choice Disengaged approach with fixed beliefs. In a crosscheck of their transcripts, it was found that three of these students (MU4, MU7 and MU36) had described themselves as atheists when they responded to the questionnaire at the beginning of the interview. A fourth student, MU17 described himself as "on the atheistic side of agnostic". The student MU33 described herself as "very religious". These comments indicate that these students held beliefs that

they were unlikely to question. The findings support the categorisations of the students' approaches as Free Choice Disengaged with fixed belief.

14.3 The Consistency of Students' Approaches

The students' Free Choice approaches were compared with their Written Dilemma approaches. Table 28 presents the results. The column labelled Consistency in this case shows how many of the student's written dilemma approaches matched his or her Free Choice approach.

Table 28

Students' Free Choice approaches

	Free Choice Approach	**Approach to Creation Dilemma**	**Approach to Life Dilemma**	**Approach to Prayer Dilemma**	**Consistency**
MU20	Engaged	Engaged	Engaged	Engaged	3
MU21	Engaged	Engaged	Engaged	Engaged	3
MU27	Engaged	Engaged	Engaged	Engaged	3
MU28	Engaged	Engaged	Engaged	Engaged	3
MU29	Engaged	Engaged	Engaged	Engaged	3
MU30	Engaged	Engaged	Engaged	Engaged	3
MU32	Engaged	Engaged	Engaged	Engaged	3
MU35	Engaged	Engaged	Engaged	Engaged	3
MU37	Engaged	Engaged	Engaged	Engaged	3
MU8	Unconnected	Engaged	Engaged	Engaged	0
MU34	Unconnected	Engaged	Engaged	Engaged	0
MU4	Disengaged with fixed belief	Engaged	Engaged	Disengaged with fixed belief	1
MU7	Disengaged with fixed belief	Engaged	Engaged	Engaged	0
MU17	Disengaged with fixed belief	Engaged	Engaged	Engaged	0
MU33	Disengaged with fixed belief	Engaged	Engaged	Engaged	0
MU36	Disengaged with fixed belief	Engaged	Engaged	Engaged	0
MU3	Disengaged with undetermined belief	Disengaged with undetermined belief	Engaged	Engaged	1
MU6	Disengaged with undetermined belief	Engaged	Engaged	Engaged	0
MU9	Disengaged with undetermined belief	Engaged	Disengaged with undetermined belief	Engaged	1
MU5	Engaged	Engaged	Engaged	Engaged	3

The results in Table 28 show that students who took Free Choice Engaged approaches approached each of the written dilemmas in a way that was consistent with this approach. The other groups of students changed their approaches for at least one dilemma. The change of approach was in all cases to an Engaged approach. This is within expectations given that the students were asked to identify apparent contradictions in the written dilemmas. Overall then, it was found that half the students in the sample changed from their Free Choice approach to an Engaged approach for at least one dilemma. These findings raise the question, did a change of approach result in a change of belief for any of these students?

14.4 The Consistency of Students' Beliefs

One of the findings of the analysis methods described above is that about half of the students in the sample changed their approach at the time of the interview from a Disengaged approach to an Engaged approach. In other words, these students indicated that prior to the interview they did not consider science-religion dilemmas in detail when forming beliefs on relevant topics. During the written dilemma section of the interview the students generally did engage in studying the dilemmas on request.

This raised the question:

- Does each student describe beliefs for each of the dilemmas that are consistent with the types of beliefs held prior to the interview?

To answer this question, a prediction was made about the beliefs that students would have held before the interview, based on their Free Choice approaches. These predicted free choice beliefs were compared with the beliefs that students were found to hold in the written dilemma section (dilemma beliefs).

The predicted Free Choice beliefs were labelled using the category labels devised for Dilemma beliefs so that comparisons could easily be made between students' Dilemma beliefs and their predicted Free Choice beliefs. The predicted Free Choice beliefs are

given in Table 29. In some cases, it was not possible to make a simple prediction based on the student's Free Choice approach, because the student's self description indicated that he or she did not consistently reach the same conclusion. For these students, the predicted beliefs are marked with an asterisk in Table 29 to indicate that they are not certain.

Table 29

Students' Free Choice Approaches and Predicted Free Choice Beliefs

Free Choice Approaches	**Predicted Free Choice Beliefs**	**Students**
Engaged: can be combined	Combined	MU29
Engaged: Favour Religion	Religion*	MU37
Engaged: Favour Science	Science*	MU27
Engaged: Open to either	Science or Religion*	MU20, MU28
Engaged: Seek to Combine	Combine*	MU5, MU21, MU30, MU32, MU35
Disengaged with fixed belief: Science Only	Science	MU4, MU7, MU17, MU36
Disengaged with fixed belief: Religion Only	Religion	MU33
Disengaged with undetermined belief	Undecided	MU3, MU6, MU9
Unconnected	Both	MU8, MU34

14.4.1.1 Results for Students who Described Taking Non-Free Choice Engaged Approaches

Table 30 presents a comparison of students' predicted Free Choice beliefs and their written dilemma beliefs for the ten students who described taking Free Choice non-Engaged approaches. The final column of Table 30 indicates how many times the student arrived at a belief that is consistent with the inferred Free Choice belief. The consistency

score in this case is obtained by adding one each time a student arrives at a belief that matches the predicted Free Choice belief. The maximum score is 3.

Table 30

Written Dilemma Beliefs and Predicted Free Choice Beliefs for Students Who Described Free Choice Non-Engaged approaches

	Free Choice Approach	**Predicted Free Choice Belief**	**Written Dilemma Belief for Creation**	**Written Dilemma Belief for Life**	**Written Dilemma Belief for Prayer**	**Number of Matches**
MU33	Disengaged, fixed belief-religion	Religion only	Religion only	Religion only	Religion only	3
MU17	Disengaged, fixed belief-science	Science only	Science only	Science only	Science only	3
MU36	Disengaged, fixed belief-science	Science only	Combined	Science only	Science only	2
MU4	Disengaged, fixed belief-science	Science only	Science only	Science only	Science only	3
MU7	Disengaged, fixed belief-science	Science only	Science only	Science only	Science only	3
MU3	Disengaged, undetermined belief	Undecided	Combined	Undecided	Undecided	2
MU6	Disengaged, undetermined belief	Undecided	Undecided	Undecided	Undecided	3
MU9	Disengaged, undetermined belief	Undecided	Undecided	Science only	Combined	1
MU8	Unconnected	Not set	Undecided	Undecided	Undecided	0
MU34	Unconnected	Not set	Religion only	Religion only	Religion only	0

14.4.1.2 Discussion: Disengaged with Undetermined Belief

In Table 30 the students have been grouped according to the type of Free Choice approach they described taking. It is interesting to look at the consistency of beliefs held by students on a group-by-group basis.

There were three students who took Free Choice Disengaged approaches with undetermined beliefs. In the interview, these students mostly changed to an Engaged approach and studied the dilemmas.

As a group, in six out of nine cases, their responses were that the dilemma was "undecided". This response is consistent with each student's Free Choice approach. In three out of nine dilemmas the students stated conclusions for the dilemmas, a response which is inconsistent with their Free Choice approaches.

14.4.1.3 Disengaged with Fixed Belief

The second group contains students who said they generally disengaged from thinking about dilemmas and who said they held predetermined beliefs on these topics. This group are the most consistent when describing the nature of their beliefs. Four out of five students arrived at beliefs for the dilemmas that were consistent with their predicted Free Choice beliefs for all three dilemmas. A fifth student was inconsistent on one occasion. In most cases, these students changed approach at the time of the interview, from one in which they did not reflect on dilemmas, to one in which they did.

14.4.1.4 Unconnected

The results presented in Table 30 show that two students did not give a belief that was consistent with their Free Choice approach for any of the dilemmas.

These students are the ones who said they took Unconnected approaches prior to the interview. In an Unconnected approach scientific and religious accounts are accepted without comparison. In the section above it was deemed likely that the beliefs held by

students taking this approach might change during the interview, and indeed this was the case.

14.4.1.5 Results for Students who Described Free Choice Engaged-Choice approaches

The results for students who described taking Free Choice Engaged approaches are given in Table 31.

Table 31

Written Dilemma Beliefs and Predicted Free Choice Beliefs for Students Who Took Free Choice Engaged approaches

	Predicted Free Choice Belief	**Written Dilemma Belief for Creation**	**Written Dilemma Belief for Life**	**Written Dilemma Belief for Prayer**	**Number of Matches**
MU29	Combined	Combined	Combined	Science only	2
MU5	Combined*	Combined	Combined	Undecided	2
MU21	Combined*	Combined	Undecided	Undecided	1
MU30	Combined*	Combined	Combined	Undecided	2
MU32	Combined*	Undecided	Neither account	Undecided	0
MU35	Combined*	Science only	Undecided	Undecided	0
MU27	Science*	Undecided	Science only	Undecided	0
MU37	Religion*	Religion only	Religion only	Religion only	3
MU20	Science or Religion*	Combined	Combined	Undecided	0
MU28	Science or Religion*	Undecided	Undecided	Undecided	0

The predicted Free Choice belief for eight of these 10 students was marked with an asterisk to acknowledge the uncertainty that the students expressed about reaching a particular outcome. Two students said confidently that science and religion were compatible on common topics and that the information from them could be combined.

Only one student in the group arrived at her stated target belief for all three topics. Looking at the results for the five students who said they sought to combine the accounts, these students arrived at a combined belief for only five of the 15 topics.

When the results from each of the groups of students are compared, the students who held fixed beliefs and who said they generally did not engage in thinking about dilemmas were the students who most often arrived at beliefs for the dilemmas that matched with their predicted Free Choice beliefs.

14.5 Students' Rationales for What to Believe

When studying students' decisions, the aim was discover a connection between these decisions and another consistent aspect of students' views. The analysis of students' rationales showed that their decisions about what to believe were unpredictable in this regard.

Students referred to a variety of factors including evidence, personal bias and common sense (see Appendix G).

Table 32 presents a summary of the rationales that students gave for their decisions about what to believe when faced with a science-religion written dilemma. Rationales that were stated within the context of a single topic are marked "-T"; rationales that were given as generalisations, such as "I'm an evidence girl" (MU7) are not marked.

Table 32

Students' Rationales for their Decisions

Rationales for Selecting or Not Selecting science

Science is unquestioningly right because it is backed by evidence	MU4, MU29, MU30, MU3-T MU7-T MU20-T MU21-T MU27-T MU35-T
Science is not proved or backed by sufficient evidence	MU36-T MU34-T
Science is plausible/ believable/ convincing	MU35-T MU17-T MU36-T
Science / Big Bang/ evolution / divine planning is not plausible / believable / convincing:	MU34-T, MU27-T, MU33-T, MU35-T, MU21-T

Rationales for selecting or not selecting religion

Religion has no evidence	MU29, MU30, MU17, MU9 MU21-T
Religion is not disproved	MU34, MU30-T
The Bible contains fairy tales	MU7, MU4,
Prayer is of value as a mental comfort only	MU3-T MU30-T MU36-T
Degree of chance / beauty indicates a Creator	MU35-T, MU34-T MU5-T
Acceptable to read Bible allegorically	MU30, MU35-T MU29-T MU29-T

Both are correct because science and religion are compatible on this issue

Science and religion are exclusively different	MU20, MU6, MU7
God created science / The Big Bang / evolution	MU9, MU9-T, MU30-T
Science leaves room for religion or vice versa	MU5, MU20-T, MU21-T
Science, religion and reality are subjective	MU3

The results in Table 32 show that students most frequently referred to the existence of evidence when explaining their decisions. There are also rationales that refer to more subjective factors, such as the plausibility of an argument. These types of rationales may indicate that these students are guided by principles which are not yet sufficiently established in their minds for them to articulate. Overall, it was concluded that students'

rationales were individualistic and often did not seem to relate to any of the other known aspects of their views (such as their views of science and religion).

The analysis of students' rationales was judged to be a relatively subjective process when compared with the contradiction-type analysis method which has clear-cut rules. For this reason, students' rationales were not included in the final descriptions of their approaches to the written dilemmas.

14.6 Chapter Conclusion

This chapter presented two additional rounds of analysis that produced interesting results but which did not provide information used in the dilemma approach descriptions.

The first section described a comparison between students' predicted Free Choice beliefs and the beliefs they arrived at in the written dilemma section of the interview. This analysis showed that the students who took a Free Choice Disengaged approach with fixed beliefs were most likely to arrive at a belief that was consistent with this approach in the written dilemma section of the interview. Within this group, each student's cognitive stage within the conceptual sequence was predicted to be a factor that would affect their consistency when they encountered the written dilemmas. An example of this was found. One student, MU36, was judged to be at stage 2. The student said that he said he had rarely thought about science-religion dilemmas in the past and had lost his religious faith through apathy. When he was asked to study the written dilemmas, the student changed his beliefs regarding one dilemma topic. A second student, MU4, said that his decision to reject religion had been made after careful reflection and was judged to be at stage 3. This student's beliefs were consistent with atheism for all three dilemmas.

Comparing the dilemma beliefs and the predicted Free Choice beliefs of the students who described taking Free Choice Engaged approaches was more complicated because these students did not say that they consistently arrived at one particular outcome.

PART 6: THE SECOND EMPIRICAL STUDY

CHAPTER 15

THE SECOND SAMPLE OF INTERVIEWS

15.1 Interview Design for the Second Study

A second study was carried out with a second group of 20 tertiary level students. A number of changes were made to some interview questions and to two of the written dilemmas for the second study.

The written dilemmas that discuss how the universe began and how human life began were revised. The reason for making the changes was that these dilemmas originally contained more than one religious view in each of the religious paragraphs. In addition to the idea of Biblical literalism, the paragraphs also referred to the practice of taking an allegorical reading of Biblical events. It could be argued that the text influenced students' ideas, particularly if they perceived that this was a way to resolve one or more apparent contradictions. The revised dilemmas present only a Fundamentalist's and a Scientific Materialist's perspective in the religious and scientific paragraphs respectively. The dilemmas are given in Appendix K.

In the second study, as in the first, students were asked to identify and discuss apparent contradictions within each dilemma. The sequence of questions was the same as for the first study except that there was an additional element at the end of each dilemma interview. Once the original questions had been addressed for each dilemma, students were given a second sheet which presented a selection of written responses to the dilemma. Each response identified an apparent contradiction and described a way of resolving the contradiction by reformulating science or religion. Students selected one or more responses from the list which were in agreement with their own views, or indicated that their view was not featured on the list.

The details of the views offered to students are given in Appendix J. As an example, Table 33 sets out the views that were offered for the dilemma of how the universe began. Students were presented with the contradictions (shown in the first column) in a bulleted list. The second column of Table 33 identifies a leading principle of science or religion that leads to a perception of the given contradiction. The information in the second column was not presented to students.

Table 33

Contradictions Presented to Students Regarding How the Universe Began

Contradictions on Creation Arising From Competing Principles on Biblical Data	**Leading Principle of Religion**
There is a contradiction because the Bible claims that the Universe began in six days.	Religion asserts Biblical literalism
The Biblical account is not meant to be read literally and so there is no contradiction about the duration of the creation.	Religion asserts the Bible need not always be read literally
No view expressed on this issue	

Contradictions on Creation Arising From Competing Principles on Divine Action	**Leading Principle of Science**
There's a contradiction because Science tells us that the universe began without a God	Science asserts no divine creation
There's not a contradiction about whether God made the universe because it is scientifically possible that God created the universe.	Science permits divine creation

15.2 Results: Qualitative Discussion

15.2.1 The Effect of Science on Faith

In this group, the number of students who felt that science had affected their beliefs was higher. Four students said that science had caused them to seriously doubt the validity of their faith. One student said that he had lost his faith as a result of his science studies:

> "Science has crushed my religious faith, basically. The greater my knowledge of science, the less my appreciation of religion" (MU55).

15.2.2 Rationales for Decisions

The rationales given by students for their decisions when faced with a perceived contradiction included a perhaps surprising perspective. It seemed that for some students, the issue of truth was not the most important factor when deciding what to believe:

> "I am looking for an answer that catches my interest. I'm an imaginative kind of person; I'm not someone who cares if it's wrong or right. I like reading science fiction and I like the imagination of it" (MU59).

> "I think everyone should be happy and we should let everyone believe what they do" (MU61).

> "I am seeking a view that makes me happy" (MU81).

> "I'm looking for simplicity. Simple things like not calling on God unless it's absolutely necessary. If it can be done by chemicals mixing by chance alone then I'd prefer that sort of an explanation" (MU60).

In the following example, the student's rationale is that a universe without meaning would be too "depressing" to be true.

> "I still tend to ignore the evolution side of it and go more on the religious side of it because the evolution side doesn't give you any answers about why man is here anyway. It may be possible we're not here for any reason at all and we're just some kind of creation that came by itself, but how depressing is that. We go to school and we go to work then we retire and then we die. There's got to be more to it than that. So that's why I go for the God side of it, not the science side of it" (MU57).

15.3 Applying the Written Dilemma Analysis System

15.3.1 Overview of Results

The transcripts were analysed by following the analysis steps set out in Chapter 12.

The results are given in Appendix I. The table of results shows the elements of information that are required to generate descriptions of the students' approaches according to the prescribed format:

> Basic category (stage within the conceptual sequence); inferred views of science and religion, Real Relationship and Contradiction-type for each contradiction, dilemma belief.

In some cases, additional or contradictory information was found when students then selected viewpoints from a list. These additional results are given in brackets.

Most of the approaches taken by students in the second sample were already featured in the existing Written Dilemma Approach model. Some examples of the insights revealed by the analysis method are given in this section both to illustrate the nature of the views held by this sample of students and to demonstrate the applicability of the analysis system.

15.3.2 Additional Approaches

A new kind of Disengaged approach with undetermined belief was taken by a student who explained that she did not consider science-religion questions herself, preferring to wait and see what solutions other people devised:

> "I'm interested but I feel like a spectator. I'm watching to see which ones wins. I'll believe the one that wins. I'm not interested in resolving it; it's just interesting" (MU59: life).

15.3.3 Relating Students' Thinking to the Stages in the Conceptual Sequence

The interviews were analysed to discover the stages of the students in the sample. When the transcripts were studied, it seemed that some students advanced in their thinking as they progressed through the interview. This, however, does not expose a weakness in the model; it merely indicates that these students were capable of advancing when they encountered an opportunity to reflect on their own ideas. Indeed since no students moved backward through the proposed conceptual sequence, this was if anything, support for the model.

15.3.4 Inferred Views of Science and Religion

Seventeen of the 20 students identified real contradictions within the written dilemmas and were inferred to hold views of science and religion that are incompatible.

In the following example, a student's view of science was inferred to resemble Scientific Materialism on the basis that he says science opposes the idea that God created life. The student's final belief is a science-only belief.

> "The contradiction is whether humans and animals were created by God ... Science is more correct. I look at the religious view and I think it's a nice way to describe it, but the scientific view has evidence" (MU55).

Another student, MU61, similarly held an inferred view of science that resembled Scientific Materialism:

> "I don't think there's any real purpose to being here. I'd like to believe I'm here for a reason but erm, I didn't realise how sciencey (sic) I was till you asked the question. I think we're just like animals."

In all, six students were inferred to hold a view of science that resembles Scientific Determinism and 12 students were inferred to have a view that resembles Scientific Materialism. One student was found to be inconsistent on this issue, and one student's views could not be inferred.

15.3.5 The View that Science Opposes Theistic Action

As was the case for the previous sample of 20 students, the perception that science opposes theistic action was again inferred to be a principle held by all the students. In this sample, 18 students addressed the issue specifically (see Appendix I). The two other students described themselves as atheists and believed that science opposes all divine action.

> "Being atheist I go with prayer is useless" (MU82).

Eight students resolved the perceived contradiction regarding theistic action by concluding that prayer cannot achieve change:

> "In that I believe I believe in God, I don't believe in an interventionist sort of God" (MU56: Prayer).

For six students, the question of theistic action was unresolved:

> "I don't know if our prayers can go against what is scientifically possible. I'm unresolved about that – I don't know whether we can walk through walls yet" (MU58).

15.3.6 Students' Awareness of Discrete Theistic Action

In the previous round of interviews, it was explained that students did not refer to the possibility of discrete theistic action. This was the case again in this round of interviews. The only kind of theistic action that was identified specifically was miraculous action:

> "Science can't explain everything and never will be able to. It's arrogant to think it could. There will always be room for miracles and science can't rule them out" (MU51);
>
> "There are miracles and supernatural events - I believe there are. Science can't explain them; Bizarre things that happen during the day" (MU57).

15.3.7 Views about the Correct Interpretation of Biblical Data

In this group, the number of students who were inferred to believe that the Bible need not always be read literally was higher (10 students). Five students did not address this issue and so their viewpoints could not be inferred and possibly were not yet formed. The remaining five students were inferred to believe that religion does require the Bible to be interpreted literally:

> "Religion says God created man from the dust out of the ground. That's not scientifically possible so that's a contradiction" (MU60);
>
> "Yes definitely - either humans evolved from apes, or we were all created from rib bones. You can't believe both" (MU61).

Of these students, two said that they believed the Biblically Literal version, for example:

"Yes, this is what I believe, just as it says here" (MU81).

15.3.8 Using the Analysis System to Clarify Students' Views

The results produced by the contradiction-type analysis method are relatively clear-cut and precise. In contrast, when attempting to analyse students' generalisations about their approaches, it was found that these were open to different interpretations. There were two examples of ambiguous self-described approaches in the second set of interviews.

In the sections at the beginnings of their interviews, two students in this group described Free Choice Engaged approaches that seemed to resemble Assimilation, the view supported by many religious scientists. A leading principle in Assimilation is that science does not oppose discrete theistic action. The following quotations illustrate their stated positions:

> "I am looking for an answer that is consistent with scientific evidence but still leaves room for religious faith" (MU51).

> "If you don't take the first testament too literally then you can resolve things... There is some evidence against the first testament and you have to accept that" (MU50).

When the contradictions that these students identified were studied, however, their views were not Assimilation in that both students expressed the view that science opposes theistic action. MU50 was inferred to have a deistic view of religion. This explained why the student saw the relationship between science and religion as harmonious. In his view, neither science nor religion claim the truth of theistic action. Despite his earlier comment, the other student identified a contradiction on the issue of theistic action having read the dilemma on prayer:

> "There is a contradiction on this. Some things can't be explained by science. We shouldn't see it as the answer to everything. It's important to have faith. I believe God can break the rules of nature if He wants to" (MU51).

15.4 Students' Selections from Prepared Responses

The views of science and religion inferred from students' selections of prepared viewpoints confirmed the findings by written dilemma analysis system regarding students' inferred views of science and religion in the cases of 18 out of 20 students. The student MU60 was inferred to hold a reformulated view of religion on the basis of a selection from the prepared viewpoints, but was inferred to hold a Biblically literal view via the main analysis method. The student MU72 was inferred to believe that science resembles materialism via the main analysis method, but selected a viewpoint corresponding to the view that science permits divine action from the prepared viewpoints.

In six cases, the findings from students' selections added more detail to the picture provided by the written dilemma analysis system. Some of this additional detail arose because students were asked to consider the possibility of contradictions relating to Biblical data and also to divine action. Several students only addressed the issue of how the Bible should be interpreted when they were asked to select a viewpoint on this issue. The additional and discrepant information found by this method is shown in brackets within the table of results presented in Appendix I.

PART 7: CONCLUSIONS

CHAPTER 16
CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

16.1 Introduction

This research presents arguably for the first time, a typology of approaches to science-religion dilemmas in which the categories are organised in a hierarchical system that refers to a conceptual sequence of development for this kind of thinking.

The work is original in that previously there was not a typology that differentiated between dilemma approaches on the basis of cognitive development. The most respected typologies of ways of thinking about science and religion that currently exist are those designed to describe the viewpoints of professional scientists, theologians and philosophers. Examples are the typologies produced by Barbour (1988), Polkinghorne (1986), Peters (1998) and Haught (1995). These typologies were not devised to necessarily encompass the views of young people today. Meanwhile most researchers who have studied how students respond to science-religion dilemmas have presented qualitative findings and have not sought to categorise the approaches that students take when they encounter a dilemma. The study carried out by Schneller (1982) is an exception. The aim of his research was like mine, to categorise students' approaches. The methodology employed by Schneller has some similarities to the methodology employed in my research, although the two projects were conceived independently. Both projects employ written dilemmas which are presented to students. From that point, the methodology used in my study differs from that used by Schneller in an important way. Schneller devised a typology of approaches by studying the approaches described in the

formal academic literature. Students were asked to read written dilemmas and were then asked to choose a response from the typology Schneller had constructed. In this way, Schneller endeavoured to discover how students would attempt to resolve the apparent contradictions within the dilemmas. On the basis of the work I have carried out, I suggest that this typology does not present the full range of approaches that tertiary students might choose to take. As both Schneller's research indicates and as my research shows, students do not always engage in reflection about a dilemma having encountered it, even when asked to do so. Schneller regarded this tendency by students to avoid thinking about the apparent contradictions as an obstacle to his project. On finding that most students selected an approach that enabled them to avoid thinking about the details of the dilemma, Schneller repeated the study with this approach removed from the list of options.

The primary instrument for data collection in my study was a semi-structured interview which included questions about science-religion dilemmas. In contrast to the methodology used by Schneller in my study, the procedure was that individuals would be asked to identify and discuss the apparent contradictions in dilemmas themselves. Interviews with 20 undergraduate students were carried out and revealed several strategies that are not described in the formal academic literature. A five-fold typology was produced that could encompass a wide range of approaches.

During the analysis of the types of contradictions that students identified, a dimension of developmental levels was identified in the transcripts, based on each individual's ability to identify and reflect on the apparent contradictions being considered. A conceptual sequence of cognitive development for this kind of thinking was devised. By drawing on this conceptual sequence, subcategories of approaches were inserted into the typology. The revised typology shows the range of approaches that are available to individuals at each of the stages. It is accompanied by a relatively precise analysis system.

Chapter 16.2 and Chapter 16.3 summarise the development of the typology and analysis system. Chapter 16.4 then discusses the findings that were produced when the conceptual

sequence was used to study the approaches taken by 40 tertiary students to selected science-religion dilemmas.

16.2 The Typology Presented in this Research

The major sources of data used to develop the typology were: a series of semi-structured interviews with 20 tertiary students about three Written Dilemmas; students' self-descriptions of the approaches they had taken as children; the formal academic literature and the literature that describes how students respond to dilemmas. Drawing on this data, five non-overlapping categories were defined that describe a wide range of ways that individuals might respond to a Written Dilemma. The categories of Written Dilemma Approaches are:

- Juvenile approach: This approach is taken by children who are not able to compare the accounts independently and so are unaware of apparent contradictions. They rely on authorities to tell them what to believe.

- Unconnected: although students taking this approach can compare the accounts, they do not bring the information into attitudinal juxtaposition, and are unaware of the differences.

- Disengaged with fixed beliefs: Students taking this approach choose not to compare the details of the accounts, having rejected science or religion totally.

- Disengaged with undecided beliefs: Students taking this approach disengage from the task of considering the dilemma leaving the issue of what to believe unresolved. They may say that these kinds of questions cannot be answered.

- Engaged: Students taking this approach engage in the task of reflecting on the dilemmas. They may identify contradictions or they may explain why there are no real contradictions.

Additionally, it was concluded that Transitional comments might be made by students who encountered the apparent contradictions for the first time and who were cognitively able to compare the accounts.

These categories relate to what is argued to be the first major decision that the student makes on encountering the dilemma which is whether to accept the task of identifying apparent contradictions. The topology has the advantage that the categories are non-overlapping which means that it is possible to give a clear-cut categorisation of an individual's approach to a dilemma. Furthermore, I argue that the characteristics that identify each category are not trivial ones – they are significant and meaningful ways to describe the thinking that underlies each approach.

16.2.1 Juvenile Approaches

The Juvenile approaches are taken by individuals who are novices in this area of thinking. One of the arguments presented in this thesis is that an individual's beliefs do not necessarily indicate the sophistication of the individual's thinking. There are professors of science and young children who are religious and who are atheists. In the typology developed here, the characteristic of the Juvenile approaches is that individuals are not capable of identifying apparent contradictions between science and religion without assistance and that they are uncritical of the beliefs they were taught.

16.2.2 Unconnected

If students are not given the opportunity to compare their scientific and religious beliefs, they may be unaware that they have learnt beliefs that contain apparent contradictions. This claim was made by Goldman (1964, 1965) who reported that some secondary school students held compartmentalised views of science and religion. Roth and Alexander (1997) reported that they also found school students who operated with a compartmentalised mindset although Fysh and Lucas (1998a) did not find evidence of this kind of thinking in the Australian students they interviewed. The research here

showed that there are students at the tertiary level students who hold compartmentalised scientific and religious beliefs. Clear evidence of this state of mind was revealed when one student (MU8) said that she discovered the apparent contradictions within her beliefs during the interview. A student who holds compartmentalised views is said in this thesis to take an "Unconnected" approach. There were no occurrences of the Unconnected Approach when this sample of students addressed the Written Dilemmas in the interviews, which is within expectations given that the students were presented with scientific and religious information simultaneously in this part of the interview.

16.2.3 The Disengaged Approaches

In the five-fold Written Dilemma typology, there are two categories of Disengaged approaches. These represent the two main reasons why students may choose not to reflect on the details within a science-religion dilemma. Students may say they already have a solution (Disengaged with fixed beliefs) or they may say they choose to leave the dilemma unresolved (Disengaged with undecided beliefs). To understand the reasoning that underlay these approaches, a study was made of students' self-descriptions of the strategies they usually took when they encountered these kinds of dilemmas.

If a student chooses to disengage from studying a dilemma then (clearly) the abilities that he or she has in this area of thinking may not be apparent. In these cases, students' reasons for disengagement reflected their stages in the conceptual sequence. In particular, some students who globally rejected science or religion revealed that they had reflected on the natures of science and religion before making this decision. This was said to indicate thinking at stage 3 or above. Others said they had drifted to a particular viewpoint through complacency. This was said to indicate thinking at stage 2.

16.2.4 The Engaged Approaches

In the written dilemma section of the interview, students were specifically asked to identify apparent contradictions. The answer to this question was used during the analysis

to determine whether the student took an Engaged approach. The category of Engaged approaches was subdivided to show the differences between the ways that individuals at different stages think about the dilemmas.

16.2.4.1 Engaged (Stage 1)

The first stage in the conceptual sequence is the Juvenile stage which is the stage at which children are not capable of comparing the accounts independently. The definition of an Engaged approach is that the individual identifies an apparent contradiction. A child at this stage cannot do this without help and so there is not an Engaged Juvenile approach..

16.2.4.2 Engaged Approaches, stage 2

The second stage in the conceptual sequence is the Narrative stage. Individuals at this stage are able to compare the accounts and identify differences between the narratives. No attempt is made to interpret these differences through a generalised scheme. This becomes apparent when individuals identify perceived contradictions in ways that are terse or wordy. Individuals at this stage have not reflected on the natures of science and religion. Their views of science and religion are unstructured collections of ideas that are drawn from their experiences and education. The approach that students take to dilemmas is what is called here a Narrative approach. Students respond to the story-like features of the two accounts and identify differences between them. They do not generalise about the nature of contradictions, and they do not reflect on the different purposes of science and religion. These claims are based on an analysis of the interviews with tertiary students carried out for this research. As will be shown here, they are also supported by the findings reported by other researchers.

In Piaget's model of intellectual development, the ability to think about abstract concepts is usually developed at an approximate age of seven. Fowler (1981) and Goldman (1965) argue however that even when students have developed the ability to think abstractly in some areas, they do not apply these cognitive capabilities to religious thinking until much

later. Instead, they conform to the beliefs of their peers and family, forming beliefs that tend to be mostly conventional Fowler (1981).

Goldman (1964) interviewed students at different ages and observed that students generally only understood that some Biblical narratives were allegorical when they reached adolescence – at about 13.5 years in age. In Goldman's view, this understanding indicated that students had developed the ability to think about abstract concepts in the context of religion.

My research looked at the views of tertiary students and found that many students interpreted the accounts presented in the Bible literally. One student explained she had rejected the (literal) accounts as "fairy tales" (MU7). This finding seems to confirm the validity of the concern expressed by Rossiter (1996) that if students are not made aware of an allegorical view of religion, they may reject religion like a fairy tale during their adolescent years. At this age, says Rossiter, students become critical of the literal version but see nothing to take its place.

16.2.4.3 Engaged Approach, Stage 3

Those who are at stage 3, the Unexamined Principled stage, hold relatively consistent views of science and religion and are able to generalise about the nature of contradictions. The views that these individuals hold are based on the understandings that they have gained through formal and informal education. At this stage, individuals have not examined their beliefs and are unaware that the natures of science and religion are not universally agreed. The significant characteristic of thinking at stage 3 is that the natures of science and religion are seen as nonnegotiable. Some alleged principles of science or religion may be said to be wrong or unproven. In contrast, the approach taken by an individual at stage 4 would be to ask whether science and religion really made the claim that is presented.

16.2.4.4 Engaged Stage 4

At the highest stage in the conceptual sequence, the Expert-Philosophical stage, individuals are aware that there are many views of science and religion. Their views of science, religion and reality are carefully considered. In some cases, an expert's beliefs may resemble those that are held by individuals at the previous stage. The nature of their final beliefs is not significant, but the method of reaching those beliefs is significant. The difference is that individuals at stage 4 have examined their views. Peacocke (1979) argues that science and religion are complementary. In contrast Dawkins (1986) supports scientific materialism while rejecting religion. The arguments presented by both authors reveal that they have reflected on a range of views of science and religion. A review of 20 publications by academics found that in each publication, there were references to several views of science and religion. To identify whether students were at stage 4, the interviews were analysed to discover whether students demonstrated an awareness of the existence of more than one view of science or more than one view of religion. In the interviews, students were asked whether they were aware of contradictions that would be perceived by others but which they themselves could explain away. Their responses to this question revealed whether they had reflected on the possibilities of other views of science and religion. Some students were found to refer to multiple views of religion but no students referred to multiple views of science.

16.3 The Dilemma Approach Analysis System

This study presents a relatively precise and systematic analysis system which can be used to analyse the way that an individual responds to a science-religion dilemmas to produce a meaningful description of the approach. The analysis system identifies what are argued to be the major decisions that the individual makes having encountered a dilemma. A number of sequences of decisions are described. Each sequence represents a type of approach. The details of the analysis were presented in Chapter 12. Several rounds of analysis are involved, two of which are described below.

16.3.1 The Contradiction-type method of Analysis

The methodology used in this study was that students were asked to identify the contradictions that they perceived to exist in the dilemmas. Students were also asked whether these contradictions were "real" in their opinions or due to misinterpretations of scientific or religious texts.

It was found that many of the contradictions identified by students related to a number of themes that are also raised in the formal academic literature.

A novel analysis method was devised that looked at the types of contradiction that students raised and inferred information about students' views of science and religion. I also proposed that this information then form part of a meaningful explanation of why each student responds in the ways observed to the dilemmas.

16.3.2 Relating Students' Responses to the Conceptual Sequence

To accompany the conceptual sequence of developmental levels, this research provided a table of characteristics of the thinking that individuals engage in for each of the stages within the sequence.

16.3.3 Describing an Individual's Approach

Using the analysis systems outlined in this study, it is possible to construct what are argued to be meaningful descriptions of the approaches that an individual takes on encountering a science-religion dilemma. The elements of information that are given in the description of an approach are:

> Basic category (stage within the conceptual sequence), Inferred views of science and religion, Real relationship and Contradiction-type for each apparent contradiction, and dilemma belief.

This systematic method of describing the approaches taken by individuals can be used to study the approaches taken by children, tertiary students and academics.

The number of details given in the description of the approach depends on the stage of the student's thinking within the conceptual sequence of cognitive development. Views of science and religion are not inferred for individuals who are judged to be at the Juvenile stage.

16.4 Findings and Discussion

This section summarises the main findings produced when the students' interviews were analysed in the prescribed manner.

16.4.1 Inferred Views of Science and Religion

In the combined sample of 40 students, the results regarding students' inferred views of religion were:

Biblical Literalism:	16 students
Reformulated Theism:	11 students
Reformulated Deism:	5 students
Theism:	7 students (unclear whether reformulated)
Inconsistent view:	1 student.

The results regarding students' inferred views of science were:

Scientific Materialism: 19 students

Scientific Determinism: 10 students

Determinism / Materialism (unclear): 7 students

Inconsistent: 4 students.

These inferred views of science and religion are based on an analysis of how each student responded to the three dilemmas in the interview. The conceptual sequence of cognitive development outlined in this thesis specifies that students at stage 2 are still establishing their understandings of science and religion. The expectation is therefore that the inferred views found by this method are not well established in the minds of students in the sample who were judged to be at stage 2.

16.4.2 Scientific Opposition of Theistic Action

When the interviews with tertiary students were analysed, it was found that none of the students held an inferred view of science that permitted theistic action. Thirty-six out of 40 students addressed the issue of theistic action directly, saying that science opposes it with the context of a dilemma; the other four identified a contradiction to the effect that science opposes all forms of divine action.

Altogether 16 students out of the sample of 40 concluded that theistic action does not occur. Five students in the group were inferred to hold a religious view that resembled deism and regarded science and religion as compatible on the issue of theistic action. Eleven students arrived at a similar final belief (that God does not act theistically) but reached this conclusion differently, saying that religion asserts theism but that science has discounted the possibility.

Eight students arrived at a belief that theistic action does take place, even though science (in their views) opposes it. Sixteen students were undecided.

Significantly, it seemed that the students who were religious or who sought to be religious and who perceived a contradiction on the issue of theistic action had not considered the approach taken by the religious scientists. It was noted that the approach of the religious scientists (judged to be at stage 4) when they encounter an apparent contradiction is to reflect on alternative views of religion and science in the hope and expectation of arriving at views that are compatible and acceptable (Berry, 1996; Haught, 1984; Houghton, 1995a; Peters, 1989). Where issues are unresolved, it is said that the human understanding of science and religion is inadequate rather than that science and religion themselves are faulty (see Barbour, 1990; Peacocke, 1996; and Polkinghorne, 1998a).

In the transcripts of the interviews with tertiary students carried out for this study, references to reinterpreting the nature of science were notably missing. Five students were inferred to hold a view of religion resembling deism and indicated an awareness of multiple views of religion but not of science. They were judged to be at stage 3-4. The other students in the group showed an awareness of one view of science and one view of religion and were judged to be at stages 2, 2-3 and 3.

In the conceptual sequence I have presented, while those at stage 4 see the interaction between science and religion as an opportunity to refine both fields (Barbour, 1988), those at stage 3 may be discouraged by it. I argue that it is easy to see why individuals at stage 3 might conclude that science or religion must be discounted entirely if in their view, one field has discredited the other.

16.4.3 The Stages of the Thinking of this Sample of Students

From the analysis of the interviews with the total group of 40 tertiary students, it was concluded that five were at stage 3-4, 14 were at stage 3, two were at stage 2-3, 19 were at stage 2.

16.4.4 An Awareness of Multiple Views

A perhaps surprising result of the research was the finding that students are likely to become aware of multiple religious views before they become aware of multiple views of science.

For example, several students explained that they did or did not take literal views of the Bible, and indicated that they were aware of an alternative view:

> "It contradicts if you think of the Bible literally. But if it's not literal it's OK" (MU29 Creation).

I was interested to find that six students objected to my use of the word "religion" at some stage during the interview or after it, advising that another term would be better since the term "religion" means different things to different people. No student questioned the use of the term "science".

On examination, this finding fits with what might be expected. I propose that students are exposed to the idea that different people hold different beliefs about the nature of religion than they are to the idea that different people hold different beliefs about science. The realisation that other people hold different views is often the step that precedes the self-examination of each student's own views and a questioning approach towards previous assumptions (King & Kitchener, 1994).

16.4.5 Rationales Given by Students for Their Decisions

This research showed that where contradictions were perceived to exist, the choices that students made about what to believe were based on many more issues than a quest to know "the truth". Some students indicated that the viewpoint they accepted was the one that "intuitively seems right" (MU28), or "provides the most imaginative answers" (MU57) or "makes life simple without added complications" (MU7). For other students, evidence was considered the most important factor.

16.4.6 Consistency

In general for the small number of dilemmas that students encountered in the interview, it was found that students were predominantly consistent with regard to their beliefs and their inferred principles of science and religion. Students' beliefs were described in Chapter 13.5 and students' views of science and religion were described in Chapter 13.4.6.3. Several students exhibited a change of approach. Before the interview just under half the students took a non-Engaged approach in which they avoided or were unaware of the issue of contradictions. During the written dilemma section of the interview most of these students changed to an Engaged approach and identified apparent contradictions when asked to do so. A discussion of the consistency of students' approaches was presented in Chapter 14.3. These findings are worthy of attention given that other studies that have reported that senior school students showed "unexpected complexity and apparent internal inconsistency" within their individual personal views (Fysh & Lucas, 1998b, p. 63). In this study, the thinking that tertiary-level students engaged in was found to be generally consistent. The change of approach that many students exhibited arose when students were asked to do something which they would not ordinarily do (identify contradictions) and in most cases did not affect the students' conclusions. The current study showed, for example, that 38 out of 40 students identified contradictions that corresponded to a consistent pairing of views of science and religion as they addressed the three science-religion dilemmas presented in the interview. Future studies could test students' consistency across a larger number of dilemmas given that the number of written dilemmas that students addressed in this interview design was just three.

16.5 Implications for Education

16.5.1 Introducing Students to a Range of Views of Science

Many studies have established that a majority of secondary and tertiary students regard the relationship between science and religion as one of conflict (Dagher & BouJaoude,

1997; Scharmann, 1993; Schneller, 1982; Smith, 1994). Rossiter (1996) considers it likely that these students perceive the relationship in this way because they regard science as equivalent to scientific materialism. My study is able to add more detail to this picture of students' views. Almost all the students who took part in the study indicated that they saw science as deterministic. Of the 40 students who were interviewed, 20 believed that science opposes all forms of divine action, a view that resembles materialism. Ten students believed that science is compatible with Divine Creation. The other ten students were concluded to hold a view that could have been scientific materialism or determinism.

With this limited range of views of science, the only students who saw the relationship between science and religion as harmonious were those who supported a deistic view of religion and believed that science does not oppose creation. Not one of the students I interviewed suggested the approach advocated by the religious scientists, that discrete theistic action is scientifically tenable.

It is surely not surprising that students arrive at a view of science that it is equivalent to Classical Scientific Determinism and that they are not aware of a wider range of views of science. The focus of secondary school science is very much on learning the so-called "laws of nature" and on demonstrating that a scientific formula can predict the result that an experiment will produce (Billingsley, 1994; Loughan, Berry, Mulhall & Gunstone 2003). The ideas of modern physics which are central in the approach of Assimilation are not part of this traditional curriculum.

The terminology used in school science further encourages students to see science as didactic and static. In previous research I found that school students understand the "laws of nature" to be the laws set by science that nature obeys. Meanwhile "experimental error" is deemed to be the error that the experiment makes when it fails to produce the answer in the textbook (Billingsley, 1994). The cold and procedural language of school science is in contrast to the engaging style that journalists use when they write about science in popular newspapers, leading many adults to regard science as interesting and vibrant (Billingsley, 1992).

The danger of leaving students with one view of science and a view that conflicts with theism, is that some religious students may resist learning scientific concepts. Several studies have shown that some students are indeed reluctant to study evolution and the scientific account of how the universe began because they fear their religious beliefs will be challenged (Borkowski, Carr, Rellinger & Pressley, 1990; Paris & Winograd, 1990), Scharmann, 1993; Smith, 1994).

Another approach that students may take if they see science and religion as incompatible is to reject religion. As my research showed, many students believed that religion intends the Bible to be read literally and then rejected this literal view. This seemed to confirm the validity of Rossiter's warning that if students are not made aware of an abstract, allegorical view of religion during their adolescent years, they may reject religion like a fairy tale (Rossiter, 1996).

In addition to rejecting science or religion entirely, there is a third approach that students take, according to my research and research by Schneller, (1982). Many students move to a strategy of disengagement in which reflection on science-religion dilemmas is avoided. Some students like MU6 in the interviews I carried out, even enforce an artificial compartmentalisation of the two fields, moving from one set of beliefs to the other depending on their circumstances.

It seems likely that many students would welcome classes that looked at the implications of modern physics for the relationship between science and religion, without necessarily studying the difficult mathematics involved. A study of science-religion dilemmas might be one way to help students to become aware of a wider range of views of both science and religion. Not one student in the sample of 40 that I interviewed indicated an awareness of the approach advocated by religious scientists that discrete theistic action is scientifically tenable. Even within the short space of an interview session, many students in the sample interviewed for this research were able to reflect on possibilities that they had not previously considered.

As long as science is only presented and discussed in the school lab, students' views of science will be limited in range and classical in nature. Encountering science in a wider

range of contexts helps students to examine their beliefs about the nature of science. Watching and taking part in debates on "science and religion" and on "science in the popular press" allow students to encounter alternative views of science. The aim is to challenge students' conception that science is a single enterprise and that it is either right (proving other beliefs wrong) or that it is wrong and can be rejected.

Knowing that there is debate on the nature of science and the nature of religion might console students who feel emotionally distressed by their perception that a relationship of conflict is the only rational view (Esbenshade, 1993; Roth & Alexander, 1997).

16.5.2 Using Science-Religion Dilemmas to Engage Students in Science

Studies in Australia and overseas show that most students enjoy science at the Primary School level, but then become disengaged at Secondary school (NBEET, 1993; Solomon, 1997). In interviews with students in primary school I found that they talked positively about the possibility of becoming scientists (Billingsley, 2000). In contrast a study that looked at the views of secondary school students revealed that most students think scientists are boring, brainy Einstein-look-alikes who work in laboratories, monitoring experiments that do not relate to the real world (Billingsley, 1999).

Too often, the topics studied at secondary school are perceived to be boring. To combat this, Baird, Gunstone, Penna, Fensham, and White (1990) suggest that teachers should engage students by challenging them with cognitively demanding tasks relating to topics that they find relevant and interesting.

I recommend that a resource of written dilemmas on science-religion topics with teacher notes would lead to a series of lessons that are intellectually engaging and educationally valuable. In the total sample of 40 students, 39 expressed at least a moderate level of interest in these topics. Many students expressed a high level of interest. The range of topics that could be addressed is wide, and includes Biology, genetics, particle science and the space sciences.

16.5.3 Addressing Teachers' Reluctance to Teach Sensitive Topics

Previous research has shown that many science teachers are reluctant to teach topics that they see as controversial (Ebenezer, 1996; Scharmann, 1993). Perhaps for fear of saying something that upsets students, teachers choose to promote a dualistic view, saying that religious beliefs will not be referred to in the science classroom. As an occasional science teacher, I have myself several times promoted this separation as a way to avoid discussing topics that do not have simple answers. The tactic is surely unfortunate given that there is currently a concern in education that students "switch off" from thinking scientifically as they walk out of the classroom. It is frequently said that students do not incorporate scientific knowledge into their own personal conceptual frameworks and as a result, they resist giving up misconceptions and immature understandings (Driver, 1988; White & Gunstone, 1989). The current informal policy by science teachers to exclude other sources of knowledge when it comes to sensitive topics surely reinforces the mental barriers that students place around science.

Science teachers' confidence would surely be raised if they had an awareness of what and how students think about these issues. Certainly this was the view of the educational publishers, Longman, who commissioned a text book containing advice for teachers and suggested lesson plans that looked at the topic of the beginning of the universe (Billingsley & Golding, 2002).

I propose that the thesis I have produced here can help teachers to predict and understand the kinds of approaches that students might initially take in a class. Teachers might be encouraged to know that this research shows that students are interested in looking at other possibilities. It also shows a number of less controversial areas that are relevant and can be investigated, such as the boundaries and nature of our physical laws. Endowed with a greater understanding about the different ways in which students are likely to assimilate this teaching, science teachers may feel better equipped to design effective lessons that they feel are morally defensible.

16.6 Further Research

The data used in this study largely came from interviews with tertiary level students. Now that the conceptual sequence and typology have been produced, it would be valuable to interview secondary school students to gather more detail about the strategies and limitations that are involved when school students encounter dilemmas of the kinds used in this study.

Another age group of interest is children in Primary school. Having taught both secondary school and primary school science, I have found that children of varying ages are keen to know more about their origins, and how the universe began and how life began. Such questions arise in the primary school classroom when students study the topic of Space. Currently teachers are uncertain about how to respond to these questions. To provide suggestions, the first step would be to interview young children and discover what their views currently are. My experience is that students at this age naturally attempt to combine their religious beliefs with the information they are hearing in the science lesson, saying for example, "Which came first, God or the stars?" My experience is also that it is a challenge to answer such questions in ways that the teacher believes will be acceptable to parents and that do not instigate the dualistic mindset described by Goldman (1965) in which science and religion are cast into separate mental boxes. The methodology for the study would include interviews with parents, teachers and students. It is an area in which there has been very little recent research.

Appendix A
The interview schedule

Introduction

Can I bother you? I'm looking for someone to interview for my PhD. It takes about half an hour. If it's OK with you, I'd like to record your answers. The interviews are anonymous when I type them up.

Once sat down

I'm looking at Science and religion and also the "Big questions" like how life began. There are no right or wrong answers, I'm interested in your ideas. By the way, if you want to stop at any time, just tell me and we'll stop. And the last thing before we start is that I'll be asking you to sign a permission form at the end of the interview, so if you're really not happy with it, you can duck out then too.

The nature of Science & Religion and the General relationship

1.1 So I'm looking at Science and religion. What do you think it's important to say about this topic?

What is science?

What is religion?

How would you describe the relationship between them?

1.5 Some people say science and religion conflict, what do you think about that view?

1.6 What about for you? Are there any clashes between science and religion for you personally? (If no) Why not?

1.7 (If yes) Do these cause you tension?

I've found from previous interviews that the word conflict can be a bit ambiguous so if it's Ok with you, let's use the word "contradict" from now on. When two things contradict, it means they can't both be true at the same time.

Interviewee's suggestion of topics and apparent contradictions

2.0 Can you think of any topics on which both science and religion have something to say?

2.1 What does science tell us about that topic?

2.2 What does religion tell us about that topic?

2.3 Are there any contradictions between those views? (What?)

2.4 TAKING EACH IN TURN: Is it a contradiction between science and religion for you personally? Why/Why not?

2.5 Does this contradiction cause you tension? Why / Why not?

2.6 Have you resolved the contradictions? How?

2.7 Can you tell me about any other contradictions that you think other people would say exist? Have you resolved this contradiction? How?

Background and previous views

3.1 When you were at school, can you think of any times when science and religion came up together?

3.2 IF YES – (a) How was the situation dealt with? (b) Were you happy with how the teacher responded to the situation?

3.3 In coming to the views you have about science and religion now, can you tell me about any changes you've made to your views – to get to the point you're at now?

3.4 How much influence do you think science has had on your religious views?

Reading Written Dilemmas And Commenting

I'm very grateful for your help here. Are you OK to keep going? The last thing I'd like you to look at is this. These are some ideas that other students have given me. I've written them into two paragraphs – one presents some scientific viewpoints and the other presents some religious viewpoints. Please read them and we'll talk about them.

4.1 First, do you have any general comments about what you've just read?

4.2 Are there any contradictions between these two views given here?

4.3 TAKING EACH IN TURN: Is it a contradiction between science and religion for you personally? Why/Why not?

4.4 Does this contradiction cause you tension? Why / Why not?

4.5 Have you resolved the contradictions? How?

4.6 Can you tell me about any other contradictions that you think other people would say exist? Have you resolved this contradiction? How?

4.7 Have you thought about this issue before?

Overall tension

5.1 How fixed are you in your views. Are you still looking for new ideas?

5.2 And my final question is how happy are you with your views?

Thank your for your help! I've got a permission form here – just have a read and then tell me if you're happy to sign it.

Appendix B

Characteristics of Students in First Sample

Students' Scientific and Religious Backgrounds

Religious: 10	Agnostic: 7	Atheist: 3
MU5	MU3	MU4
MU8	MU6	MU7*
MU20	MU9	MU36*
MU21*	MU17	
MU29*	MU27*	
MU30*	MU28	
MU33	MU32	
MU34		
MU35		
MU37		

* indicates science student

Ages of Students

Age	Number of Students
18	3
19	7
20	3
22	2
23	3
25	1
29	1

Average age is 20.7 years

Appendix C

Repeated Themes During Interviews

Student ID and number of times the theme was repeated	Quotation Selected from the General Part of the Interview	Quotation Selected from Student's Response to a Written Dilemma	Researcher's Summary of the Theme
MU3 1	I believe in being warm and that you can control how you feel about things, not the things. It doesn't matter how we got here and we'll probably never know	There is a contradiction but not for me because I don't have a strong view (Prayer)	I don't have a strong view
MU4 1	I have a rational view which causes me to discard the religious view	Once it's explained scientifically it shatters the religious view (Life)	I have a rational view
MU5 3	I try to adapt them to each other without totally disregarding the other.	I agree with the scientific explanation. The religious view given here was how they tried to explain things in the old days. But I still think a higher power directed it in some way (Life). I think there was an overall plan, and things happened in the scientific way. I'm trying to resolve the two together. I want to hold onto both (Creation). There are some things science can't explain, which I attribute to God (Prayer).	I want to combine them
MU6 3	If I'm thinking about religion, I take a religious kind of view, but if I'm thinking in a science way, I take the science view. I used to want answers. Now I don't think about it.	I hadn't thought about this before. I don't know if it's a conflict for me. It might be now. It's not worrying me right now, but it might later (Creation). Even though I know it's up in the air and unresolved, I don't care any more (Prayer). I don't have to have an answer any more (Life).	I avoid confronting these issues

MU7 3	I'd like to believe religion but another part of me says no, it's just a fairy tale.	As a biology student, I see that we decompose into mushroom food (Life after death). I've seen a lot of evidence for the scientific version and not much for the religious viewpoint. I'm an evidence girl (Life). I don't think God can bring across the winds or make rain (Prayer). I think of prayer as a way to soothe personal conflict. I go with the scientific view (Prayer)	I'd like to have faith but it is not rational
MU8 3	I haven't thought about them together before. Now I think they are linked. I used to think they were separate. The more I think, the more confused I am.	I was taught to believe both of them and I haven't formed my own belief. They're two totally different views –either something greater made us or evolution made us from mud (Life). I don't think I'll resolve it. My beliefs are in two different areas. I've discussed this a lot but only from a religious aspect. I need to sit down and take a closer look. It's too hard and you can't bring them together. I haven't thought about it like this before (Prayer).	I have believed both without examining hem together
MU9 1	It's possible that scientific laws and theories could have been created by some God.	I think it's possible God created the Big Bang (Creation).	I believe God created science
MU17 2	Over the years science has disproved a lot of supernatural ideas. That destroys religion	Science and logic are my religions. I think we're here by accident. There's no divine plan. There's no meaning to life (Life).	Science disproves religion

MU20 2	Full of conflicting ideas I'm still looking at both, trying to decide.	The religious view says one thing and the scientific one says another. You can't combine them because they're different views (Prayer). Science has evolution with facts like fossils. But I don't know what they say about the start (Life).	I am seeking to combine them
MU21 2	I'm constantly changing my views. I try to find links and matches between them	I think evolution is right, but the origin of evolution wasn't an accident. I try to match them – I think maybe for God six days is like six billion years (Life). The evidence supports the Big Bang and I accept that. (But then) Science is supposed to be logical but it seems so illogical for a universe to exist for nothing. Science doesn't offer a reason for why it's here (Creation).	I am seeking to combine them
MU27 1	Not really resolved. It's not something I think about much	I haven't resolved it - I don't think about it much (Creation).	I avoid confronting these issues
MU28 1	They conflict, they're so completely different	Definitely a conflict. You have to choose which view to take. There's no answer (Life).	You have to choose
MU30 3	They're not completely opposite nor exclusive. There is a way to combine them but I'm not sure how. You have to look at religion in a different way, knowing science. I think God created science.	I don't believe you have to have one or the other. God made evolution or God allowed us to evolve (Life). I believe both. There's not a contradiction because the religious view is spiritual. There's so much in science we haven't discovered. (Creation)	You can combine science and religion; God made science.
MU33 1	The areas of apparent conflict are in areas of uncertainty so I tend to give precedence to the religious side.	Definitely a contradiction. I'm unconvinced that evolution happened in the fashion suggested. It's a theory not proved. I'm not sure if I believe it (Life).	I do not find the scientific evidence convincing

MU34 3	I guess because I haven't done a lot of science studies, I haven't been forced to question everything I believe... and I've been able to say, yeah, there's no contradiction still for me. People say the evidence isn't there to show the Bible and God are true. But I'd say, you can't prove they're not true either. Take a step of faith	They can't prove there was a Big bang or evolution (Creation). They're different views that contradict. I don't think everything could be this perfect unless it was created by God (Life). I believe there is a God and he probably doesn't want to turn the world upside down, but he can do whatever he wants (Prayer).	I put religion first
MU36 2	My religious views have evaporated	Clearly there's a contradiction because they say different things. The scientific theory is impossible to prove but it seems more credible. I've resolved it in favour of Darwin (Life). I can't believe in prayer, other than as a way to comfort people (Prayer)	Science is more credible
MU37 2	There's conflict but I'm not a science-based person so I don't think about it much.	There's a contradiction. For me there's Adam and Eve but I'm not sure how it works for other races (life) There's a contradiction but I've resolved it because of my faith. I believe there's a reason for everything and God works in mysterious ways (prayer)	I put religion first

To get an approximate indication of the consistency of each student's approach, the comments that each student made in the topic section were compared with those made in the general section of the interview. If students repeated a point he or she made in the general section when they gave a response to a topic, the consistency score was increased by one. The maximum consistency score is 3, which would indicate that the responses to all three topics repeated points made in the general section. Students' comments are only included in this table if they repeated a theme at least once.

Appendix D

Students' Stated Views About the Natures of Science and Religion

MU3	Science is the search for physical truth, religion is the search for emotional truth
MU4	Science is rational; religion fills the gaps
MU5	Two ways to explain things
MU6	Science is facts with evidence, religion is beliefs
MU7	Science is facts with evidence, religion is beliefs
MU8	Facts with evidence, spiritual beliefs
MU9	Laws and theories, spiritual beliefs
MU17	Observations, spiritual beliefs
MU20	Observations; why we are here
MU21	Facts with evidence, spiritual beliefs
MU27	Facts with evidence, spiritual beliefs
MU28	Facts with evidence, uncertainty
MU29	How and why; ideals
MU30	Laws and theories, spiritual beliefs
MU32	Facts, beliefs
MU33	Physical reality, why we're here
MU34	Proved theories; stories
MU35	Facts; spiritual beliefs
MU36	Logical, supernatural
MU37	Evidence, beliefs

Appendix E

Students' Views of the General Relationship Between Science and Religion and Free Choice Approaches

ID	Quotation that indicates Self-Described Free Choice-Choice approach	General Relationship	Self-described Free Choice Approach
MU3	There needn't be a conflict. I treat them equally and am open to both. I believe in being warm and that you can control how you feel about things, not the things.	They needn't conflict	Free Choice Disengaged – not interested
MU4	In religion there has to be faith and in Science there's no faith ... it's a big contradiction. I have a rational view which causes me to discard the religious view.	Real contradictions	Free Choice Disengaged with fixed belief: science only: exclusive fields
MU5	Often they tend to clash. It depends how you look at it. I try to adapt them to each other without totally disregarding the other.	Clash but depends how you look at it	Free Choice Engaged: Seek to Combine
MU6	They contradict. If I'm thinking about religion, I take a religious kind of view, but if I'm thinking in a science way, I take the science view.	Real contradictions	Free Choice Disengaged – Alternate
MU7	They're separate. You can't believe in both. I'd like to believe religion but another part of me says no, it's just a fairy tale.	Real contradictions	Free Choice Disengaged with fixed belief: science only (exclusive fields)
MU8	I haven't thought about them together before. Now I think they are linked. I used to think they were separate. The more I think, the more confused I am.	Unaware - Real contradictions	Transitional
MU9	It's possible that scientific laws and theories could have been created by some God. I don't have a defined view. I'm not sure.	They needn't contradict	Free Choice Disengaged – not interested and Suggests Combine
MU17	Over the years science has disproved a lot of supernatural ideas. That destroys religion.	Real contradictions	Free Choice Disengaged with fixed belief: science only (exclusive fields)
MU20	Full of conflicting ideas I'm still looking at both, trying to decide.	Real contradictions	Free Choice Engaged: open minded
MU21	I'm constantly changing my views. I try to find links and matches between them.	Real contradictions	Free Choice Engaged: Seek to Combine
MU27	It's not something I think about much. I take the more scientific approach.	Real contradictions	Free Choice Disengaged with fixed belief: science only
MU28	They totally contradict; they're so completely different. I'm uncertain. I don't have any facts. I don't think about it.	Real contradictions	Free Choice Engaged

MU29	They needn't contradict.	Needn't contradict	Free Choice Engaged: can combine
MU30	They're not completely opposite nor exclusive. There is a way to combine them but I'm not sure how. You have to look at religion in a different way, knowing science. I think God created science.	They needn't contradict	Free Choice Engaged: Seek to Combine
MU32	There's conflict but they can be made to fit together.	Real contradictions	Free Choice Engaged: Seek to Combine
MU33	The areas of apparent conflict are in areas of uncertainty so I tend to give precedence to the religious side.	Real contradictions	Free Choice Engaged: favour religion
MU34	I guess because I haven't done a lot of science studies, I haven't been forced to question everything I believe... and I've been able to say, yeah, there's no contradiction still for me. People say the evidence isn't there to show the Bible and God are true. But I'd say, you can't prove they're not true either. Take a step of faith.	No contradictions	Was Unconnected Free Choice Disengaged with fixed belief: Religion only (science evaporated)
MU35	They're different. I'm willing to accept either view and find out what is right.	Real Contradictions	Free Choice Engaged: Seek to Combine
MU36	On the theories of evolution and the Creation of the universe, there are contradictions. My religious views have evaporated.	Real contradictions	Free Choice Disengaged with fixed belief: Science only (religion evaporated)
MU37	There's conflict but I'm not a science-base person so I don't think about it much.	Real contradictions	Free Choice Disengaged with fixed belief: Religion only (science evaporated)

Appendix F

Contradiction-types Identified by Students

Student	Quotation from Transcript Identifying Apparent Contradiction	Contradiction-Type and Real Relationship
MU3 Creation	I don't believe or disbelieve either view. I don't have a theory myself.	Disengaged with undetermined belief (Doesn't attempt to identify a contradiction)
Life	God decided to create life versus it began by chance.	Real Contradiction on theistic action
Prayer	There's a will that directs things versus things just happen.	Real Contradiction on theistic action
MU4 Creation	God created the universe versus it happened without God. They contradict.	Real Contradiction on divine creation
Life	They contradict. Life evolved versus God created Adam and Eve.	Wordy contradiction with Biblical data
Prayer	I don't believe Prayers can be answered because I don't believe in a powerful God.	Disengaged with fixed belief (Doesn't attempt to identify a contradiction)
MU5 Creation	Some people think there's a contradiction on whether the universe was created in six days or took billions of years to evolve.	Apparent-only Contradiction on Biblical data (Refers to multiple views)
Creation	It's not really a contradiction. Science says things happened by nature and religion says God created the means to make things happen. They can both be true.	Compatible on divine creation
Life	God created each thing individually versus life evolved. I think there was an overall plan and things happened in the scientific way.	Real Contradiction on theistic action Compatible on divine creation
Prayer	The world has its own formula versus praying makes a difference. Contradict.	Real Contradiction on theistic action
MU6 Creation	Science says it happened one way versus religion says it happened another way. Contradict.	Terse contradiction
Life	The contradiction is about whether humans started with Adam and Eve or whether humans evolved. Contradict	Real Contradiction on Biblical data
Prayer	One says you get what you ask for versus it can't happen. Contradict	Real Contradiction on theistic action
MU7	God created Earth for man versus everything came about individually	Real Contradiction on Biblical data

Life	The religious view says there was Adam and Eve and the science view says life evolved and the religious view is that God suddenly created life and the science view is that it happened gradually. Contradict.	Wordy contradiction with Biblical data
Prayer	One says it works versus one says it doesn't.	Real Contradiction on theistic action
MU8 Creation	The contradiction is that they're totally different beliefs.	Terse contradiction
Life	Who made us – evolution or creation from mud? They're two totally different views –either something greater made us or evolution made us from mud.	Wordy contradiction with Biblical data
Prayer	One says prayer works and the other says it doesn't.	Real Contradiction on theistic action
MU9 Creation	The science idea is that the universe began because of the scientific laws and the religious idea is that the universe began because of God. It doesn't have to be a contradiction. It's possible that scientific laws and theories could have been created by some God.	Apparent-only Contradiction on divine creation (Refers to multiple views)
Creation	Science has the Big bang theory and religion has creation. There doesn't have to be a contradiction. I think God created the Big Bang.	Apparent-only Contradiction on divine creation (Refers to multiple views)
Life	I don't have a view. It's not something I think about. We're here now.	Disengaged with undetermined belief
Prayer	It depends on who you ask and their faith. People who want to believe in the power of prayer perceive a contradiction. I don't perceive a contradiction because I don't believe in prayer.	Apparent-only Contradiction on theistic action (Refers to multiple views)
MU17 Creation	The universe is here because it was hand crafted in a few days versus it took billions of years. There's a contradiction because science says it's here because of the interactions of atoms and religion says it was God.	Real Contradiction on Biblical data Real Contradiction on divine creation
Life	Science says life began by accident and religion says it was planned.	Real Contradiction on divine creation
Prayer	God can hear our prayers versus there is no one listening.	Real Contradiction on theistic action
MU20 Creation	One says the Earth came from nowhere with no creator versus the earth was designed.	Real Contradiction on divine creation*
Life	The religious one says God created life versus life evolved. They contradict. Science has evolution with facts like fossils. But I don't know what they say about the start. God created it and now it's following the plan.	Wordy contradiction with Biblical data Compatible on divine creation

Prayer	Prayers work versus prayers do nothing. You can't combine them because they're different views.	Real Contradiction on theistic action
MU21 Creation	God created the universe versus evolution. I don't accept God created the universe as it's described in the Bible – the six days – I believe in evolution. But I accept that the universe came into being because of a supreme being. Science can't answer the fundamental question – why did it happen.	Real Contradiction on divine creation Real Contradiction on Biblical data
Creation Topic: (same as above)	The evidence supports the Big Bang and I accept that. (But then) Science is supposed to be logical but it seems so illogical for a universe to exist for nothing. Science doesn't offer a reason for why it's here. Science is saying it can explain the universe as it is versus religion says it can't.	Real Contradiction on divine creation Real Contradiction on divine creation
Prayer	One says God responds to prayers and science says He doesn't	Real Contradiction on theistic action
MU27 Creation	One says God created it versus the other says it just happened. Contradict.	Real Contradiction on divine creation
Life	One is giving a scientific view and the other is giving a totally different view. They contradict.	Terse contradiction
Prayer	They contradict. I don't think about it much.	Real Contradiction on divine creation (terse contradiction)
MU28 Creation	They're completely opposite views. Definitely a contradiction. I don't know the answer.	Terse contradiction
Life	Humans evolved from apes versus God created us. Definitely a contradiction. You have to choose which view to take. There's no answer.	Real Contradiction on divine creation
Prayer	One's saying by praying you're not making anything happen, versus its saying if you pray to God to change this, then it will happen. Definitely a contradiction.	Real Contradiction on theistic action
MU29 Creation	The Bible says that the world was created in six days. Science says it was molecules. It contradicts if you think of the Bible literally. But if it's not literal it's OK.	Apparent-only Contradiction on Biblical data (Refers to multiple views) Compatible on divine creation

Life	The Bible says it was Adam and Eve and science says it was evolution. God may not have created Adam and Eve but he may have been the one to have initiated the whole evolution thing in the beginning and is now watching it through the years. That's becoming the current religious view.	Apparent-only Contradiction on Biblical data (Refers to multiple views) Compatible on divine creation
Prayer	It's not a contradiction if God is just watching.	Apparent-only Contradiction on theistic action (Refers to multiple views)
MU30 Creation	God Created the universe versus the big bang. I believe both. There's not a contradiction because the religious view is spiritual. It's hard. I think you can combine them somehow … you have to look at religion in a different way knowing that there are a lot of scientific things out there.	Compatible on divine creation Apparent-only contradiction on Biblical data (Refers to multiple views)
Life	I don't believe the Adam and Eve story literally.	Compatible on Biblical data
	Either we didn't evolve and God made everybody different versus science shows we are evolving. I don't believe you have to have one or the other. God made evolution or God allowed us to evolve.	Compatible on divine creation
Prayer	I don't know. I think they're different things... Maybe. I'm a bit dubious about Prayer changing physical things. It's hard to see how a Prayer is going to affect someone who's sick. So that's a conflict I haven't resolved.	Real Contradiction on theistic action
MU32 Creation	Science has one explanation and religion has another. Definitely a contradiction.	Terse contradiction
Life	One has the ape theory and one has the Adam and Eve theory. They contradict.	Wordy contradiction with Biblical data
Prayer	There's always a contradiction..	Real Contradiction on theistic action (terse)
MU33 Creation	There is a physical contradiction.	Real Contradiction on Biblical data
Life	One says there is a purpose to life and the other says there is no purpose. Definitely a conflict.	Real Contradiction on divine creation
Prayer	One says God answers prayer versus He does not. Contradict.	Real Contradiction on theistic action
MU34 Creation	Yeah, they're both different. Contradict,	Terse contradiction

Life	They're different views that contradict. The universe has a purpose versus there's no purpose.	Terse contradiction Real contradiction on divine creation
Prayer	The contradiction is that there is a God who exists and is all-powerful and can bring change versus there is no God.	Real Contradiction on miraculous action Real Contradiction on divine creation
MU35 Creation	They contradict. I can't believe God planned it all (Creation).	Real Contradiction on divine creation
Life	Science says it happened by chance and religion says it was an act of God	Real Contradiction on divine creation
Life	(On the question of Adam and Eve): I don't take a literal view.	Compatible on Biblical data
Prayer	They contradict. One says God answers prayers and one says there's no way he can.	Real Contradiction on theistic action
MU36 Creation	Science says things happened because of some fundamental law of nature versus the religious view is that God had a guiding hand.	Real Contradiction on divine creation
Life	Either we evolved from apes or God created us. Clearly there's a contradiction because they say different things. Either we evolved from apes or God created us.	Real Contradiction on Biblical data Real Contradiction on theistic action
Prayer	One says there is a higher Power at work versus there is not.	Real Contradiction on theistic action
MU37 Creation	God created the universe versus he didn't. There is a contradiction.	Real Contradiction on divine creation
Life	Religion says God created the universe and then man and then woman versus science has everything physical and they have evidence. There's a contradiction.	Real Contradiction on Biblical data Real Contradiction on Biblical data theistic action
Prayer	There is because one says God is at work and the other says it's just the molecules.	Real Contradiction on theistic action

Appendix G

Students' Rationales for their Decisions

Rationales that Referred Plausibility and Common sense

The scientific account is plausible/ believable/ convincing	MU35, MU17, MU36
The scientific account is not plausible / believable / convincing	MU34, MU27, MU33, MU21, MU35

Rationales that Referred to Evidence

Evidence supports the science	MU29, MU30, MU3, MU7, MU20, MU21, MU27, MU35,
Evidence supports religion (eg beauty of world)	MU35, MU34,
Lack of evidence for science	MU36, MU34,
Lack of evidence for religion	MU29, MU30, MU17, MU9
The religious account is not disproved	MU34, MU30,
Evidence disproves the religious account	MU7, MU4, MU29, MU5,

Rationales that were Self-Contradictory

Things happen for scientific reasons but if you wish for something it will happen	MU28

Appendix H

Collated Results and Written Dilemma approaches for all 20 Students in the First Sample

Students who Described a Free Choice Disengaged Approach with Fixed Belief (Science only)

	Inferred View of Religion	**Inferred View of Science**	**Creation: Approach and Contradiction**	**Belief**	**Life: Approach and Contradiction**	**Belief**	**Prayer: Approach and Contradiction**	**Belief**
MU4	Biblical Literalism	Scientific Materialism	Engaged: Real contradiction on divine creation	Science only	Engaged: Real contradiction on Biblical data (wordy)	Science only	Disengaged with fixed belief	Science only
MU7	Biblical Literalism	Scientific Determinism / Materialism	Engaged: Real contradiction on Biblical data	Science only	Engaged: Real contradiction on Biblical data (wordy)	Science only	Engaged: Real contradiction on theistic action	Science only
MU17	Biblical Literalism	Scientific Materialism	Engaged: Real contradiction on Biblical data Real contradiction on divine creation	Science only	Engaged: Real contradiction on divine creation	Science only	Engaged: Real contradiction on theistic action	Science only
MU36	Biblical Literalism	Scientific Materialism	Engaged: Real contradiction on divine creation	Combined	Engaged: Real contradiction on Biblical data Real contradiction on theistic action	Science only	Engaged: Real contradiction on theistic action	Science only

Students who Described a Free Choice Disengaged approach with fixed belief (Religion-only)

MU33	Biblical Literalism	Scientific Materialism	Engaged: Real contradiction on divine creation	Religion only	Engaged: Real contradiction on Biblical data	Religion only	Engaged: Real contradiction on theistic action	Religion only

Students who Described a Free Choice Disengaged approach with Undetermined Belief

	Inferred View of Religion	**Inferred View of Science**	**Creation: Approach and Contradiction**	**Belief**	**Life: Approach and Contradiction**	**Belief**	**Prayer: Approach and Contradiction**	**Belief**
MU3	Theism	Scientific Determinism / Materialism	Disengaged with undetermined belief	Undecided	Engaged: Real contradiction on theistic action	Undecided	Engaged: Real contradiction on theistic action	Undecided
MU6	Biblical Literalism	Scientific Determinism / Materialism	Engaged: Unidentified real contradiction (terse)	Undecided	Engaged: Real contradiction on Biblical data	Undecided	Engaged: Real contradiction on theistic action	Undecided
MU9	Reformulated Deism	Scientific Determinism	Engaged: Compatible on divine creation Compatible on divine creation	Combined	Disengaged with undetermined belief	Undecided	Engaged: Compatible on theistic action	Science only

Students who Described a Free Choice Unconnected approach

	Inferred View of Religion	**Inferred View of Science**	**Creation: Approach and Contradiction**	**Belief**	**Life: Approach and Contradiction**	**Belief**	**Prayer: Approach and Contradiction**	**Belief**
MU8	Biblical Literalism	Scientific Determinism / Materialism	Engaged: Unidentified real contradiction (terse)	Undecided	Engaged: Real contradiction on Biblical data (wordy)	Undecided	Engaged: Real contradiction on theistic action	Undecided
MU34	Theism	Scientific Materialism	Engaged: Unidentified real contradiction (terse)	Religion only	Engaged: Real unidentified contradiction (terse) Real contradiction on divine creation	Religion only	Engaged: Real contradiction on miraculous action Real contradiction on divine creation	Religion only

Students who Described a Free Choice Engaged approach

	Inferred View of Religion	**Inferred View of Science**	**Creation: Approach and Contradiction**	**Belief**	**Life: Approach and Contradiction**	**Belief**	**Prayer: Approach and Contradiction**	**Belief**
MU21	Biblical Literalism	Scientific Materialism	Engaged: Real contradiction on divine creation Real contradiction on Biblical data	Combined	Engaged: Real contradiction on divine creation Real contradiction on divine creation	Combined	Engaged: Real contradiction on theistic action	Undecided
MU27	Theism	Scientific Materialism	Engaged: Real contradiction on divine creation	Undecided	Engaged: Real unidentified contradiction (terse)	Science only	Engaged: Real contradiction on divine creation (terse contradiction)	Undecided
MU5	Reformulated Theism	Scientific Determinism	Engaged: Compatible on Biblical data Compatible on divine creation	Combined	Engaged: Real contradiction on theistic action Compatible on divine creation	Combined	Engaged: Real contradiction on theistic action	Undecided
MU20	Biblical Literalism	Scientific Materialism* Scientific Determinism*	Engaged: Real contradiction on divine creation* Real contradiction on Biblical data (Wordy) Compatible* on divine creation	Science only	Engaged: Real contradiction on Biblical data (Wordy) Compatible* on divine creation	Combined	Engaged: Real contradiction on theistic action	Undecided
MU28	Theism	Scientific Materialism	Engaged: Real unidentified Contradiction (terse)	Undecided	Engaged: Real contradiction on divine creation	Undecided	Engaged: Real contradiction on theistic action	Undecided

MU29	Reformulated Deism	Scientific Determinism	Engaged: Compatible on Biblical data. Compatible on divine creation	Combined	Engaged: Compatible on Biblical data Compatible on divine creation	Combined	Engaged: Compatible on theistic action	Science only
MU30	Reformulated Theism	Scientific Determinism	Engaged: Compatible on divine creation Compatible on Biblical data	Combined	Engaged: Compatible on Biblical data Compatible on divine creation	Combined	Engaged: Real contradiction on theistic action	Undecided
MU32	Biblical Literalism	Scientific Determinism / Materialism	Engaged: Real unidentified contradiction (terse)	Undecided	Engaged: Real contradiction on Biblical data (wordy)	Neither	Engaged: Real contradiction on theistic action (terse)	Undecided
MU35	Reformulated Theism	Scientific Materialism	Engaged: Real contradiction on divine creation	Science only	Engaged: Real contradiction on divine creation Compatible on Biblical data	Undecided	Engaged: Real contradiction on theistic action	Undecided
MU37	Biblical Literalism	Scientific Materialism	Engaged: Real contradiction on divine creation	Religion only	Engaged: Real contradiction on Biblical data Real contradiction on Biblical data theistic action	Religion only	Engaged: Real contradiction on theistic action	Religion only

Appendix I

Results for the Second Set of Interviews

	Free Choice Approach	Stage	Inferred View of Science	Inferred View of religion	Creation: Approach and Contradiction	Belief	Life: Approach and Contradiction	Belief	Prayer: Approach and Contradiction	Belief
MU50	Engaged: can be combined	3-4	Determinism	Reformulated Deism	Engaged: Compatible on Biblical data Compatible on divine creation (multiple views)	Combined	Engaged: Compatible on Biblical data Compatible on theistic action	Science-only	Engaged: Compatible on theistic action	Science-only
MU51	Engaged: Seek to Combine	3	Determinism	Reformulated Theism	Engaged: Compatible on Divine Creation	Combined	Engaged: Real contradiction on theistic action	Combined	Engaged: Real contradiction on theistic action	Religion only
MU52	Disengaged with fixed beliefs - Religion-only	2	Materialism	Biblical literalism	Engaged: Wordy contradiction	Religion only	Disengaged with fixed belief: religion only	Religion only	Engaged: Real contradiction on theistic action (terse)	Religion only
MU53	Engaged	3	Determinism	Reformulated Theism	Engaged: Real contradiction on theistic action Compatible on Biblical data	Undecided	Engaged: Real contradiction on theistic action	Science only	Engaged: Real contradiction on theistic action	Science only
MU54	Disengaged with fixed beliefs - science only	2	Determinism or Materialism	Biblical literalism	Engaged: Wordy contradiction	Science only	Engaged: Terse contradiction	Science only	Engaged: Real contradiction on theistic action	Science only

MU55	Disengaged with fixed beliefs - science only	3	Materialism	Reformulated theism	Engaged: Real contradiction on Divine Creation	Disengaged with fixed beliefs - science only	Engaged: Compatible on Biblical data Real contradiction on theistic action	Science only	Engaged: Real contradiction on theistic action	Science only
MU56	Engaged	2	Materialism	Reformulated theism	Engaged: Terse contradiction	Undecided	Engaged: Compatible on Biblical data	Neither	Engaged: Real contradiction on theistic action (terse)	Science only
MU57	Engaged: seek to combine	2-3	Materialism	Reformulated Theism	Engaged: Real contradiction on Divine Creation	Religion only	Engaged: Real contradiction on Theistic Action Compatible on Biblical data	Religion only	Engaged: Real contradiction on theistic action	Religion only
MU58	Disengaged with undetermined beliefs	2-3	Determinism	Theism (Reformulated)	Engaged: Compatible on Divine Creation (Compatible on Biblical data)	Combined	Engaged: Real contradiction on Theistic action	Undecided	Engaged: Real contradiction on theistic action	Undecided
MU59	Disengaged with undetermined beliefs:	2	Materialism	Theism	Disengaged with undetermined belief: No contradiction identified	Undecided	Disengaged with undetermined belief: No contradiction identified	Undecided	Engaged: Real contradiction on theistic action (terse)	Undecided
MU60	Engaged	2	Materialism	Biblical literalism (Reformulated Theism*)	Engaged: Real contradiction on divine creation (Compatible on Biblical data)	Terse undecided	Engaged: Wordy contradiction with Biblical data	Science only	Engaged: Real contradiction on theistic action (terse)	science only

MU61	Disengaged with undetermined beliefs	2	Materialism* then Determinism*	Biblical literalism	Engaged: Real contradiction on Divine Creation	Science only	Engaged: Wordy contradiction with Biblical data	Undecided	Engaged: Real contradiction on theistic action (terse)	Undecided
MU72	Disengaged with fixed beliefs - Science only	3	Materialism (Determinism)	Reformulated Theism	Engaged: Real contradiction on Divine Creation No contradiction on Biblical data	Science only (Compatible on Divine Creation)	Disengaged with fixed beliefs - Science only: No contradiction identified	Science only	Disengaged with fixed belief – science only: No contradiction identified	Science only
MU81	Engaged	2	Materialism or Determinism	Biblical literalism	Engaged: Wordy with Biblical data	Religion only	Engaged: Wordy with Biblical data	Religion only	Engaged: Real contradiction on theistic action	Religion only
MU82	Engaged: Seek to Combine	3	Materialism	Theism (Reformulated)	Engaged: Real contradiction on Divine Creation (Compatible on Biblical data)	Undecided	Engaged: Compatible on Biblical data Real contradiction on theistic action	Undecided	Disengaged with fixed beliefs - science only: no contradiction identified	Science only
MU83	Disengaged with fixed beliefs - reject both	2	Materialism	Theism	Engaged: Terse contradiction	Undecided	Engaged: Terse contradiction	Undecided	Engaged: Real contradiction on theistic action (terse)	Undecided
MU84	Engaged	3	Materialism	Deism (Reformulated Deism)	Engaged: Compatible on Divine Creation (Compatible on Biblical data)	Combined	Engaged: Compatible on theistic action	Science only	Engaged: Compatible on theistic action	Undecided
MU85	Engaged	3	Determinism	Theism	Engaged: Real contradiction on theistic action	Combined	Engaged: Real contradiction on theistic action	Religion only	Engaged: Real contradiction on theistic action	Religion only

MU87	Engaged: They can be Combined	3	Determinism	Reformulated Deism	Engaged: Compatible on Divine Creation	Combined	Engaged: Compatible on Theistic action Compatible on Biblical data	Combined	Engaged: Compatible on Theistic action	Science only
MU92	Engaged	2	Scientific materialism* determinism*	Biblical literalism	Engaged: Wordy contradiction with Biblical data	Undecided	Engaged: Terse contradiction	Undecided	Engaged: Real contradiction on theistic action (terse)	Science only

Appendix J

Students' Selections from Viewpoints Offered (Second Sample)

Creation Dilemma

Contradictions on Creation Arising from Competing Principles on Biblical data	**Leading Principle of Religion**	**Students who Selected This view**
There is a contradiction because the Bible claims that the Universe began in six days.	Religion asserts Biblical literalism	52, 54, 61, 81
The Biblical account is not meant to be read literally and so there is no contradiction about the duration of the creation.	Religion asserts reformulated Biblical data	50, 51, 53, 55, 57, 58, 59, 60, 72, 82, 84, 87, 92
Declines to give a view on this issue		83, 85

Contradictions on Creation Arising From Competing Principles on Divine Action	**Leading Principle of Science**	**Students who Selected This view**
There's a contradiction because science tells us that the universe began without a God	Science asserts no divine creation	52, 54*, 55, 56, 57, 59, 60, 61*, 72, 81, 82, 83, 84, 92
There's not a contradiction about whether God made the universe because it is scientifically possible that God created the universe.	Science permits divine creation	50, 51, 53, 58, 61*, 85, 87

Detail of Belief	**Type of Belief**	**Students who Selected This view**
The universe began with no divine intervention	Science only	54*, 55, 61
God created the universe but not as it says in the Bible.	Combined	50, 51, 53, 57, 72, 87, 92
God created universe, don't know how (deism)		84, 85, 58
The religious account is correct exactly as given in the Bible	Religion-only	52, 81
Undecided	Undecided	59, 60, 82, 83
None of these		56

Life Dilemma

Contradictions on Life Arising from Competing Principles on Biblical data	**Leading Principle of Religion**	**Students who Selected This view**
There's a contradiction because religion tells us that life began with Adam and Eve.	Religion asserts Biblical literalism	52, 54, 61
There is no contradiction because the story of Adam and Eve is given as a story.	Religion asserts reformulated Biblical data	50, 51, 53, 55, 56, 57, 58, 59, 60, 72, 82, 84, 87, 92
No view on this issue		83, 85

Contradictions on Life Arising From Competing Principles on Divine Action	**Leading Principle of Science**	**Students who Selected This view**
There's a contradiction because science tells us that the life began without any kind of act of God	Science asserts no divine action of any kind	52, 55, 56, 57, 59, 60, 61*, 72, 81, 82, 83, 84, 92
There's no contradiction because it's scientifically possible that God created a universe in which life evolved by itself.	Science allows divine creation	50, 51, 53, 54*, 58, 61*, 85, 87

Detail of Belief	**Type of Belief**	**Students who Selected This view**
Life began with no divine intervention	Science only	54, 55, 72, 81
God created life but not as it says in the Bible.	Combined	50, 51, 57, 85, 87
God created life don't know how		84
The religious account is correct exactly as given in the Bible.	Religion only	52
Undecided	Undecided	53, 56, 58, 59, 60, 61, 82, 83, 92

Prayer Dilemma

Contradictions on Prayer Arising From Competing Principles on Divine Action	**Leading Principle of Religion**	**Students who Selected This view**
There is a contradiction because religion says that God can respond to prayers and science says He cannot	Religion asserts theistic action and science opposes theistic action	51, 52, 53, 54, 55, 56, 57, 58, 60, 72, 81, 82, 83, 85, 92
There is not a contradiction because God works invisibly through the forces of nature to respond to prayers	Religion asserts theistic action and science does not oppose discrete theistic action	
There is not a contradiction because religion does not claim that God answers prayers	Religion does not assert theistic action	50, 84, 87

Detail of Belief	**Type of Belief**	**Students who Selected This view**
Prayers cannot bring about physical change except by comforting people	Science only	50, 53, 54, 55, 56, 60, 72, 81, 82, 87, 92
God works invisibly through the forces of nature to respond to prayers	Combined	
God can do whatever He wants and can respond miraculously to prayers	Religion only	51, 52
Undecided	Undecided	57, 58, 61, 84
None of the views given		83

Appendix K

Revised Dilemmas for Second Round of Interviews

Evolution or creation: A scientific view

Darwin's modern followers argue as follows. Billions of years ago, life began by chance from chemicals that existed in water. These complex chemical molecules were able to replicate or copy themselves. In time, more complicated organisms were formed, leading eventually to plants then animals and humans. In the struggle for survival, the strongest and most aggressive animals fared better than weaker creatures. Eventually humans appeared and triumphed over all the other species on the planet. To summarise, life began by chance and evolved from simple organisms to more complicated animals. Humans are here now because we have evolved from a line of species that are sufficiently aggressive to survive at the expense of weaker species.

Evolution or creation: A Religious View

According to the bible, God created people in the following way. First he created a man, in his own image, or likeness. The man was formed from dust in the ground, and then God breathed life into his nostrils, and the man became a living being. Adam lived and worked in the Garden of Eden, taking care of the land and naming the animals. Then God said that the man shouldn't be alone. No helper could be found, so God put Adam to sleep, took one of his ribs, and made a woman from it. The man and his wife were both naked and they felt no shame.

To summarise, we were created in our current form by a loving God. We are not the result of chance, we were planned.

The beginning of the universe :A scientific view

According to the "Big Bang" theory, the universe began fifteen billion years ago as a tiny speck of incredible energy. It then expanded over billions of years to reach the vast size it is today. Scientists have deduced this because they see clues in space today that show the universe is still expanding. The dot of energy spread out, and some of the energy changed into particles of matter. Experiments in high energy colliders have shown how these "fundamental" particles could then have combined to create atoms and molecules. Gradually the material began to clump, forming stars and planets. To summarise, science can explain how the universe transformed from micro-dot to the beautiful complexity here now, using natural forces. There is no role or need for "Higher powers" in this scenario.

The beginning of the universe: A religious view

In the beginning, there was nothing, except for God. Even space and time didn't exist. With a miracle, God created light. He formed the light just using words by commanding it to begin. Then he created the Earth, the sky, the water on the Earth and the clouds in the sky. He put plants and animals on the Earth and fish in the sea. After each creation, he looked at his work, and judged it to be good. The last thing to be created were people – first Adam, then Eve. The creation happened over six days, and on the seventh day, God rested. To summarise, God created the universe in a series of miracles.

Appendix L

Books Studied to Discover Academics' Approaches to Science-religion Dilemmas

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